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Water and Wastewater Operators' 1993 Seminar

Alberta
ENVIRONMENTAL PROTECTION

PRESENTATIONS

MADE AT THE 18th ANNUAL

ALBERTA OPERATORS SEMINAR

BANFF PARK LODGE

March 9,10, 11, 12, 1993

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The Alberta Water and Wastewater Operators' Seminar is an annual updating and general technical information program co-sponsored by the Alberta Water and Wastewater Association, the Municipal Branch Standards and Approvals Division Alberta Environment, and the Western Canada Water and Wastewater Association. The Seminar is designed to be of interest to treatment plant operators, distribution and collection system operators, and village and town foreman and superintendents. A wide variety of topics relating to water treatment, water distribution, wastewater collection, and wastewater treatment are discussed. Displays set up by equipment and product suppliers provide an opportunity for operators to view the latest in treatment equipment.

This publication is a collection of the presentations made at the Seminar in 1993.

The Municipal Branch Standards and Approvals Division Alberta Environment, as well as the co-sponsoring organizations, assumes no responsibility for opinions or statements of facts expressed by contributors. Speakers' opinions do not necessarily represent official policy.

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SPEAKERS LIST

Name & Company	Topic
Guy Jette, Head Operator, Water Treatment Plant City of Fort McMurray	WATER TREATMENT IN KWEKWE, ZIMBABWE
Ken Richardson, C.E.T., Distribution & Transmission Operations, City of Edmonton	OPERATION, MAINTENANCE, AND DESIGN OF WATER DISTRIBUTION RESERVOIRS
Ken Voss, P.Eng., Project Engineer, Waterworks Division, City of Calgary	FREEZE THAW DEWATERING OF ALUM BASED SLUDGE
Brent Applegate, Operator Water Treatment Plant, Wandering River, Alberta	DESLUDGING & INSTALLING AERATION & FLOATING INTAKE IN A RAW WATER RESERVOIR
Al Kennedy, P.Eng., Regional Engineer, Alberta Environmental Protection, Red Deer, Alberta	PROCEDURES FOR CHANGING WATER TREATMENT CHEMICALS
Stephen B. Tilson, National Training Manager, Sreco-Flexible, Torrington, Connecticut	ARE YOU READY FOR THE 21ST CENTURY?
Frank J. Odill, Vice President, Cretex Specialty Products, Waukesha, Wisconsin	MANHOLE SEALING AND REHABILITATION
Garry Drachenberg, P.Eng., Process Mechanical Engineer, Associated Engineering Alberta Ltd. Edmonton, Alberta	HYDRAULIC MODELLING
Jim Yule, President, Colony Viking Services Ltd., St. Paul, Alberta	SNAP JOINT METHOD OF RELINING SANITARY MAINS FROM MANHOLE TO MANHOLE

SPEAKERS LIST

Name & Company	Topic
Bob Vatcher, Operator III, Water Treatment Plant, Lethbridge, Alberta	OVERVIEW OF WATER & SEWAGE CONDITIONS IN ICA, PERU
Doug Cruickshank, President, Loss Control Consultants Limited, Edmonton, Alberta	METER READING TECHNOLOGIES - PAST TO PRESENT
Mark Emery, Accounts Manager, NALCO, Edmonton, and Grant Bergquist, Supervisor, Water Treatment Plant, Slave Lake, Alberta	USE OF A STEAMING CURRENT MONITOR TO OPTIMIZE ALUMINEX AT THE TOWN OF SLAVE LAKE
Taylor Green, P.Eng., Electrical & Controls/ Instrumentation Designer, Associated Engineering Alberta Ltd., Edmonton, Alberta	RETROFITTING VARIABLE SPEED DRIVES INTO EXISTING PUMPING SYSTEMS
Russ Ayers-Berry, Operations Manager, Lambourne Environmental, Eckville, Alberta	COST EFFECTIVE HASSLE FREE SLUDGE MANAGEMENT
Andy Maguire, Operator, Water Treatment Plant City of Edmonton, Alberta	PLANNING STRATEGIES FOR VARIABLE CONDITIONS
J. Laurie Mielke, Laboratory Technician, City of Calgary Bearspaw Water Treatment Plant Calgary, Alberta	USING PARTICLE COUNTING TO COMPARE FILTER MEDIA IN A DRINKING WATER TREATMENT PLANT
Steve Blonsky, Superintendent, Town of High Prairie High Prairie, Alberta	SAFETY WORKSHOP

SPEAKERS LIST

Name & Company	Topic
Ted Tatem, Agrologist, City of Calgary Calgary, Alberta	CITY OF CALGARY'S CALGRO OPERATION
Robert R. Chisholm, P.Eng., General Manager, Alberta One Call Location Corporation, Calgary, Alberta	ALBERTA 1ST CALL
Eleanor Wright, Pitsel and Associates, Calgary, Alberta	BREAK UP OR BREAK DOWN - CREATIVE STRATEGIES FOR COPING WITH STRESS

DISPLAYERS

COMPANY NAME	REPRESENTATIVE
AABLE PUMPING AND BLENDING INC. Box 9, Site 3, RR # 3, Red Deer, AB, T4N 5E3	Milligan, Dave Milligan, Harvey
ACCU-FLO METER SERVICES LTD. 4028 - 7th Street SE. Calgary, AB T2G 2Y8	Mayer, Steve Muihead, Bill
ACE INDUSTRIES (INT'L) CORP., Box 3604, Airdire, AB., T4B 2B8	Murphy, Marton
AGAT LABORATORIES 3801 - 21 Street NE Calgary, AB T2E 6T5	Murphy, Marton Brownlee, Dennis Fetherstonhaugh, Terry Lynn
AKW TECHNOLOGIES 2015 - 42 Street Edmonton, AB., T6L 6L6	Whitehead, Jack
ALBERTA MEQUIPCO LTD. #406, 8989 MacLeod Trail SW Calgary, AB T2H 0M2	Clarke, Brian Stephen, David
ALBERTA TRAFFIC SUPPLY LTD., 7798 - 16 Street Edmonton, AB., T6P 1L9	Davies, Ken Young, Dennis
ANACHEMIA SCIENCE, Edmonton, AB.,	Mitchell, Glenn Vander Meulen, Jane

DISPLAYERS

COMPANY NAME	REPRESENTATIVE
ANTHRATECH WESTERN INC. 4232 - 16A Street S.E. Calgary, AB T2G 3V1	Hambley, David M. Hambley, Philip R.
AUTOMATED AQUATICS CANADA LTD. 5823 - 90 Street Edmonton, AB T6E 6C2	Costigan, Joe Martin, Darrel
BADGER METER INC., 59 Woodside Sq., Fonthill, ON., L0S 1E4	Were, Earl
B.C.A. INDUSTRIAL CONTROLS LIMITED # 5, 6115 - 4th Street SE Calgary, AB T2H 2H9	Gariepy, Serge Willdig, Brian
BIG 'O' INC. Box 1780 Taber, AB T0K 2G0	Fletch, Don Grunsky, Hank
CAN-CON GAS SERVICES LTD. # 101, 9333 - 45 Avenue Edmonton, AB T6E 5Z7	Bothwell, Ken Kolochuk, Al
CANUS INDUSTRIES INC. 3927 Grant Street Burnaby, BC V5C 3N4	Parkinson, Robin Wise, John
CARRYING INDUSTRIES OF ALBERTA LTD. 2115 - 91 Avenue Edmonton, AB T6P 1L1	Guenette, Rick

DISPLAYERS

COMPANY NAME	REPRESENTATIVE
CCD EDMONTON LIMITED, 180 Kaska Road, Sherwood Park, AB., T8A 4G7	Bagnall, Tim
CCD WESTERN LIMITED, Bag D, 6815-40 Street SE, Calgary, AB, T2L 2W7	Sullivan, Tim
CH2M HILL ENGINEERING LTD. 1600, 555 - 4th Avenue SW., Calgary, AB., T2P 3E7	Wobma, Paul
CLOW CANADA 1724 - 58 Street NE Calgary, AB T1Y 1M9	Easter, Stuart Ferraro, Dan
COLONY VIKING SERVICE LTD. # 1840, 10123 - 99 Street Edmonton, AB T5J 3H1 & Box 1520 St. Paul, AB T0A 3A0	Yule, Jim Yule, Kathryn
CONSOLIDATED CONCRETE LTD., 5340 - 1st Street SW, Calgary, AB, T2H 0C8	Pildysh, Mike Popoff, Len
CRP PRODUCTS LTD. 2129 - 84 Avenue Edmonton, AB T6P 1K1	Poljanski, Nike Teixeira, Gil
ECODYNE LIMITED , # 340,10333 Southport RD SW., Calgary, AB., T2W 3X6	Richer, Guy C.

DISPLAYERS

COMPANY NAME	REPRESENTATIVE
ECONO ENVIRONMENTAL PRODUCTS 5340 - 1 Street SW., CALGARY, AB., T2H 2N8	McCafferty, Frank
ELENOR ENTERPRISES LTD.	MacDonald, Charles Madsen, Claus
ELJAY IRRIGATION LTD., # 3, 3700 - 78 Avenue SE., Calgary, AB., T2C 2L8	Kohlen, Brian Lesser, Henry
ELSRO CONSTRUCTION PRODUCTS 38 Rayborn Crescent St. Albert, AB T8N 3C7	Onishenko, Merv Thibodeau, Gord
EMCO DISTRIBUTION GROUP	Ellinger, Basil Sawchuk, Dale
FISCHER & PORTER (CANADA) LTD. 225-200 Rivercrest Drive SE Calgary, AB T2C 2X5	Drennan, Jim Radloff, Shayne
FLEX-LOX PIPE LIMITED	Roulston, Tim Stauble, Cliff
FORD METER BOX CO. 775 Mancherster Avenue Wabash, Indiana 46992	Burd, Jim
FULLKOTE PIPELINE SERVICES INC. # 101, 7477 - 49 Avenue Red Deer, AB T4P 1N1	Adams, Brenda Venables, Don

DISPLAYERS

COMPANY NAME	REPRESENTATIVE
GALVANIC ANALYTICAL SYSTEMS LTD., 5664 Burleigh Cres. SE., Calgary, AB, T2H 1Z8	Clarke, Randy Rogers, Ken
GASTECH INSTRUMENTS CANADA LTD., 1721 - 27 Avenue NE., Calgary, AB., T2E 7E1	Berezay, Janie
GRENCO INDUSTRIES LTD.	Grenke, Wes Rhyason, Roger
HAYWOOD GORDON LIMITED	Luit, Marten
HEATH CONSULTANTS LTD. 6923 Farrell Rd., 1st Flr Farrell Plaza Calgary, AB T2H 0T3	Gough, David Hollingshead, Bert
HI SIGNS MANUFACTURING LTD. 4403 - 84 Avenue Edmonton, AB T6B 2S6	Adam, Ken Howard, Steve
IGL CANADA LIMITED, 17515 - 106 A Avenue, Edmonton, AB., T5S 1M7	Foster, Ken Zaborski, Don
INDUSTRIAL MACHINE INC., 1077 Hidden Valley Dr., Sandy, Utah, USA 84094	Rivas, Tony
ITT FLYGT 6704 - 30th Street SE Calgary, AB T2C 1N9	Rankin, Ray

DISPLAYERS

COMPANY NAME	REPRESENTATIVE
ITT FLYGT 10554 - 169 Street, Edmonton, AB, T5P 3X6	Seibert, Ray
ITT FLYGT CANADA	Barg, Carl Maltais, Francis
J. A. SMITH & ASSOCIATES LTD. 66, 740 Bracewood Dr. SW, Calgary, AB., T2W 3N3	Zverina, Jana
JMM OPERATIONAL SERVICES, # 1840, 10123 - 99 Street, Edmonton, AB., T5J 3H1	Clevenger, Wendy Nelms, Gene Wilgosh, Joseph
JOHN BROOKS CO. LTD. **/GORMAN RUPP,** 1936 - 25 Avenue NE Calgary, AB T2E 6Z4	Roy, Dean Stevenson, Peter
KUBOTA CANADA LTD., 2620 Viscount Way, Richmond, BC., V6V 1N1	Wagner, Rich Koloff, Don
LAMBOURNE ENVIRONMENTAL Box 119 Eckville, AB T0M 0X0	Ayers-Berry, Russ Kinzel, Wayne
LE-RON PLASTICS 12485 - 82 Avenue Surrey, BC V3W 3E8	Collisson, Bruce Comfort, Bob McPhee, Bruce Watts, Ron

DISPLAYERS

COMPANY NAME	REPRESENTATIVE
LYNCH RESOURCES LTD. 336 - 40 Avenue NE Calgary, AB T2E 2M7	Campbell, Roy C.
MACKENZIE & FEIMANN LTD. 12835 - 146 Street Edmonton, AB T5L 2H6 Kelman,John	Vogel, Mark
MACKENZIE & FEIMANN LTD. 3225 - 54 Avenue S.E. Calgary, AB T2C 0A9	Johnston, Clay
MAR-TECH INSITUFORM LTD. 8363 - 128th Street Surrey, BC V3W 4G1	Olsen, Mike Swanson, Don
MCKAY WATER WORKS SUPPLY LTD. Box 894 Lacombe, AB T0C 1S0	McKay, Lewis A. Fincham, Lorne R.
MICRO-KLEEN INC.	Kostuk, Ken
MILLTRONICS, P.O. Box 3632, Airdrie, AB., T4B 2B8	Lazure, Gary MacBeath, Dave
MUELLER CANADA, Box 173, Site 7, R.R. #1, Calgary, AB, T2P 2G4	Kelman, John
MUIS CONTROLS LTD.	Kiely, Bruce Muis, Bill

DISPLAYERS

COMPANY NAME	REPRESENTATIVE
NEWMAN HATTERSLEY LIMITED, 9738 - 51 Avenue, Edmonton, AB., T6E 0A6	Lent, Frank
NORWOOD FOUNDRY LTD. Box 152 Nisku, AB T0C 2G0	Anderson, Bev Freeborn, Doug Johnson, Dale
PACIFIC WEST INSPECTION INC., 2938 Pinnacle Street, Coquitlam, BC., V3C 3S9	LeClerc, Leo
PEACOCK INC. 2715 - 18th Street NE Calgary, AB T2E 7E6	Brophy, Wayne Disney, Bob
PIPELINE SUPPLY INTERNATIONAL # 207, 1435 Nelson Street, Vancouver, BC., V6G 2Z3	Turgoose, Peter B.
PLAINSMAN MANUFACTURING LTD. 5928 - 99 Street Edmonton, AB T6E 3N9	Beattie, Dave James, Gail
PRAIRIE FLOW PRODUCTS INC., 18219 - 98 A Avenue, Edmonton, AB., T5T 3L5	Anderson, Gary
PRAIRIECHEM INC. 5516E - 40 Street SE Calgary, AB T2C 2A1	Blondin, Lance Boisjoli, Don Hauca, Harold

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COMPANY NAME	REPRESENTATIVE
PRECON PRECAST PRODUCTS 3603 - 8th Avenue N Lethbridge, AB T1H 5C8	Cunningham, Jim Timmerman, Robin
QQR MECHANICAL CONTRACTING LTD., P.O. Box 3176, Sherwood Park, AB., T8A 2A6	McDonald, Scott
QUADRO COATINGS INC., # 201, 8173-128th Street, Surrey, BC., V3W 4G1	Daniel, Trevor Ogilvie, Gary
RENE'S VACUUM SERVICE LTD., R.R. # 1, Legal, AB., T0G 1L0	Maurier, Mark Maurier, Rene
ROBAR INDUSTRIES LTD. 12945 - 78 Avenue Surrey, BC V3W 2X8	Hack, Ralph Johnson, Roger
SCEPTER /CANRON, 4225 - 92 Avenue Edmonton, AB T6B 3M7	Bosch, John Congram, Lionel Desiatnyk, Richard Hume, Glenn
SEEPEX	Hersberger, Gordon
SENSUS TECHNOLOGY 109 Carr Crescent Okotoks, AB T0L 1T1	Walsh, John Douthit, David

DISPLAYERS

COMPANY NAME	REPRESENTATIVE
STANCHEM, 9637 - 45 Avenue, Edmonton, AB, T5J 2L4	Gunoff, Brent Korchinski, Jim
SUMMIT VALVE & CONTROLS LTD.	Bain, Allan, Raftis, Roy
TDH FLUID SYSTEMS INC., 9439 - 47 Street, Edmonton, AB., T6B 2R7	Loehr, Alan
TDH FLUID SYSTEMS INC., # 305, 1301 - 8th St SW, Calgary, AB., T2R 1B7	Tabert, Bernhard
THURO SERVICES WESTERN LTD. Box 303 Station T Calgary, AB T2H 2G9	Bedard, Paul Varro, A.P.
TRENCHLESS REPLACEMENT SYSTEMS LTD. 1600, 144 - 4th Avenue SW Calgary, AB T2P 3N4	Chan, Wing Smith, Mike
TROJAN INDUSTRIAL DISTRIBUTORS 4119 - 17 Street SE Calgary, AB T2G 3W5	Bumstead, Dave Dane, John McPhail, Mark
URECON INSULATION LTD. Box 210 Calmar, AB T0C 0V0	Anderson, John Killingworth, Ted

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COMPANY NAME	REPRESENTATIVE
VAN WATERS & ROGERS, 16803 - 118 Avenue, Edmonton, AB,	Finch, Ron
WALLACE & TIERNAN CANADA INC. # 102, 2003 - 14th Street NW Calgary, AB T2M 3N4	Matsugu, George Moore, Bill
WESTBURNE INDUSTRIAL ENT. 3840 - 8th Street SE Calgary, AB T2G 3A7	Gallant, Brian Millette, Ron
WESTERN SUPPLIES LIMITED 14635 - 121A Avenue Edmonton, AB T5L 2T2	Goodsell, Ken Menzies, Ian VanDer Gucht, George Yeske, John
WESTERN WATER & SEWER SUPPLIES 1978 # 1, 7139 - 40 Street SE, Calgary, AB., T2C 2H7	McRae, Tim, Thompson, Jim
WESTERN WATER UTILITIES SERVICES	Place, David Zdebiak, Gary
WJF INSTRUMENTATION (1990) LTD. # 5, 3610 - 29th Street NE Calgary, AB T1Y 5Z7	Douglas, Geoff Fletcher, Jack
ZENON/GLADWALL ENGINEERING SERVICES LTD. 6213 Wagner Road Edmonton, AB T6E 4N4	Fraser, Peter O'Geil, Ron

DISPLAYERS

COMPANY NAME	REPRESENTATIVE
ZPE LTD., 66, 740 Bracewood Dr. SW,, Calgary, AB., T2W 3N3	Zverina, Milan

BANFF SEMINAR - 1993 Delegates

Name	Employer
Adamkewicz, Brian	County of Athabasca
Allen, Lawrence	City of Wetaskiwin,
Applegate, Brent	Wandering River WTP
Arneson, Bruce	Town of Oyen
AuCoin, Steve	Town of Grande Cache
Bakker, Frits	Townsite of Redwood Meadows
Barrett, John	City of Calgary
Bebbington, Andy	Town of Devon
Becker, Dan	City of Medicine Hat
Bellwood, Dennis	Town of Fox Creek
Bergquist, Grant	Town of Slave Lake
Best, Ray	Town of Stavely
Billey, Barry	County of Barrhead
Blades, Jim	City of Red Deer
Bleau, Rick	Municipal District of Cypress
Blonsky, Steve	Town of High Prairie
Boettcher, Stan	Town of Castor
Bouchard, Robert	County of St. Paul
Bowers, Jack	Town of Faro
Boyle, Barry	Village of Cremona
Braat, Marco	Improvement District #23
Bradbury, Dennis	Town of Hay River
Brady, Brian	Town of Vermilion
Bramley, Allen	Village of Beiseker
Browne, Vern	Town of Rimbey
Brunes, Lloyd	Town of Hay River
Budd, Mike	Town of Crossfield
Buyar, Walter	Improvement District #16
Campbell, Blair	Town of Vermilion
Chalifoux, Bernie	City of Edmonton
Chant, Scott	Village of Barons
Cheney, Gordon	Town of Hanna
Clarke, Lester	City of Fort Saskatchewan
Clift, Bill	Town of Olds
Coker, Al	County of Red Deer
Colban, Kim	City of Spruce Grove
Cole, Randy	Town of Eckville
Collin, Wally	Town of Milk River
Connolley, Ken	Town of Rimbey
Cornell, Jim	City of Fort Saskatchewan

Name	Employer
Coulter, R. Lynne	City of Grande Prairie
Crowchild, Vincent	Sarcee Development
Cunningham, Mark	Peavine Metis Settlement
Daniels, Keith	City of Edmonton
Desjarlais, Henry	Elizabeth Metis Settlement
Dickout, Stuart	Enchant Water Users
Dixon, Grant	Improvement District of Yellowhead
Dobrosky, Darcy	Town of Oyen
Drachenberg, Garry	Associated Engineering
Drinkill, Graham	Town of Gibbons
Dunsmore, Jack	M.D. of Taber #14
Dyrland, Dale	Heritage Pointe Golf & Country Club
Dziengielewski, Ed	Town of Peace River
Ehmann, Paul	Municipal District of Kneehill
Einarson, Robert	Town of Rocky Mountain House
Emick, Jeff	Town of Irvine
Engel, Blaine	County of Lethbridge
Feitzelmayer, Gus	Saskatchewan Environment & Public Safety
Feltmate, Colleen	City of Edmonton
Fenske, Bill	Town of Swan Hills
Fitzgerald, Bruce	Town of Nanton
Forester, Wilfred	City of Leduc
Formanek, Ernie	Town of St. Paul
Fowler, Glen	Town of Canmore
Freng, Ron	City of Lethbridge
Gadke, Dean	Village of Mannville
Gallagher, Bob	Municipal District of Badland No.7
Gardon, John	County of Thorhild No.7
Gauchier, Keith	Peavine Metis Settlement
Giacchetta, Bruce	City of Lethbridge
Gibb, Boyd	Alberta Metis Settlements Transition
Gordey, Alan	Town of Sexsmith
Green, Taylor	Associated Engineering
Greenaway, Pat	Town of Fort MacLeod
Grenier, Ron	Town of Slave Lake
Grossell, Ken	City of Edmonton
Gullion, Gordon	Improvement District 17 East
Harder, Harry	Town of Vulcan
Harding, Ed	N.A.I.T.
Harris, Doug	Town of Lacombe
Hedberg, Louis	Town of Devon

Name	Employer
Hellard, Dennis	City of Calgary
Henke, Bob	Village of Acme
Henson, Chuck	Municipal District of Cypress No.1
Henson, Don	Improvement District 18S
Heron, Edward	Buffalo Lake Settlement
Hicks, Dave	City of Edmonton
Hier, Lyle	Village of Thorsby
Hill, Dave	Municipality of Crowsnest Pass
Hilsen, Bill	Improvement District 18N
Hingley, Burt	Village of Lomond
Hocchausen, Francis	Municipal District of Provost #52
Hollman, Gerard	Town of Ponoka
Holman, Morley	Village of Onoway
Holroyd, Murray	Town of Bashaw
Huculak, Steve	City of Drumheller
Hunsperger, Perry	Village of Glenwood
Irons, Wally	Town of Cochrane
Irwin, Wayne	Town of Cold Lake
Janssen, Hans	Town of Didsbury
Jeffcoat, Stan	Hardisty General Hospital
Jeffrey, John	Village of Ryley
Jette, Guy	City of Fort McMurray
Jimmy, Harold	County of Leduc #25
Johnson, David	City of Airdrie
Jones, Fred	Municipality of Crowsnest Pass
Karwandy, Thad	1992 Westerra Award Receipent
Kellsey, Brian	City of Edmonton
Kendrick, Al	City of Drumheller
Kennedy, Al	Alberta Environment - Red Deer
Kerbes, Deane	County of Stettler No.6
Kluthe, Irwin	M.D. of Sturgeon
Koch, John	City of St. Albert
Kozuback, Bob	Village of Rycroft
Krahn, Bob	Improvement District #22
Kurze, Richard	Town of Picture Butte
Lagadyn, William	City of Edmonton
Lavorato, Lou	City of Lethbridge
Letkeman, Stan	Village of Cereal
Lockhart, Steven	Town of Banff
Loeffler, Bert	Village of Cayley
Loose, Ken	CFB Suffield
Lucas, Rick	Syncrude Canada

Name	Employer
Lundy, Randy	Town of Milk River
Lupul, Troy	Town of Canmore
Lyckman, Larry	Village of Carmangay
Magnan, Henry	Town of Beaumont
Maguire, Andrew	City of Edmonton
Mair, George	City of Whitehorse
Maldander, Larry	Village of Tilley
Marchildon, Ernie	Town of Falher
Mastre, Deryle	Parks Canada - Jasper
Matthews, Steven	Improvement District #17C
McClelland, Murray	Town of Turner Valley
McGeachy, Scott	County of Wetaskwin #10
McGinn, Terry	Alberta Environment - Edmonton
McIntosh, Larry	Village of Blackie
McKinney, Neil	Town of Mayerthorep
McLean, Gord	City of Calgary
McMartin, Mark	Village of Irricana
Merrick, Blake	M.D. of Sturgeon #90
Miller, Bert	Town of Whitecourt
Mills, Rod	City of Red Deer
Mitchell, Richard	Town of High Level
Moeller, Pete	Village of Berwyn
Monti, Jim	Town of Vauxhall
Moritz, Dennis	Town of Olds
Neurohr, George	Alberta Environment - Grande Prairie
Nicoll, Gayle	Town of Daysland
Nixon, Glen	Town of Carstairs
Nuttall, Steve	City of Lethbridge
One Spot, Allan	Townsite of Redwood Meadows
Ouellette, Gabe	Town of Bonnyville
Paisley, Bil	Town of Hanna
Parker, Barry	Town of Swan Hills
Parslow, Errol	Town of Carstairs
Peach, Brian	Town of Hardisty
Pears, Jim	Village of Carbon
Peck, Frank	Town of Sylvan Lake
Pelkey, Steve	CFB Wainwright
Perrette, John	CFB Penhold
Peters, Jim	Town of Sundre
Pickering, George	Hays Water Plant
Polachek, Peter	Town of Cochrane
Potter, Leonard	Town of Canmore

Name	Employer
Powell, Ed	Town of Trochu
Powelson, Max	Town of Raymond
Prentice, Bill	Town of Brooks
Preville, Clem	Town of St. Paul
Proulx, Robert	Village of Legal
Pullishy, Elmer	Town of Lamont
Reinhardt, Steve	City of Edmonton
Resch, Larry M.	Town of Three Hills
Richardson, Ken	City of Edmonton
Richter, Manirod	Town of Picture Butte
Ridley, Bill	Village of Chauvin
Riemann, Walter	Town of Coaldale
Riep, Glen V.	Municipal District of Starland No.47
Roberts, Gordon	Village of Caroline
Roberts, John	City of Edmonton
Roberts, Mike	Improvement District #15
Robins, Cal	Town of Stony Plain
Robinson, Dave	CFB Suffield
Royko, Arnold	Town of Athabasca
Salata, John	City of Lethbridge
Saunders, Alan	Town of Bon Accord
Savard, Michel	City of Leduc
Sawicki, Peter	Town of High River
Schlachter, Rod	Town of Canmore
Schneider, Jim	Improvement District #17W
Schrader, Tim	Town of Hinton
Schultz, Brad	Town of Stony Plain
Sebry, Larry	Town of Lacombe
Shepherd, Bob	City of Spruce Grove
Shewchuk, Dan	Village of Nampa
Shybunka, Orest	Improvement District of Yellowhead No.14
Siewert, Gerry	City of Camrose
Sinclair, Ed	Village of Mirror
Soderberg, Edward	Town of High River
Songer, Clare	County of Grande Prairie No. 1
Stafford, Dalton	City of Lethbridge
Stevenson, Jack	Municipal Foothills No. 31
Still, Brian	Village of Stirling
Strachan, Allan	County of Strathcona
Sutherland, Robin	Town of Wembley
Symington, Calvin	Municipal District of Provost #52

Name	Employer
Thoma, John	Town of Fairview
Thompson, Albert	Town of Rocky Mountain House
Thompson, Kevin	Town of Rocky Mountain House
Thorson, Doug	City of Red Deer
Traer, Rick	N.W.T. Power Corp.
Tratch, Michael	Village of Boyle
Tuchscherer, Lyle	County of Forty Mile #8
Unger, Jack	City of Grande Prairie
Valiquette, Ray	Town of McLennan
Vance, Karey	Canada Parks Service
Vatcher, Bob	City of Lethbridge
Veldhuis, Richard A.	Village of Nobleford
Volk, Larry	Town of Ponoka
Wackenhut, Jason	Parks Canada
Wallace, Clarke	Village of Rockyford
Watson, Randy	Village of Elnora
Waughtal, George	Town of Spirit River
Wells, Gary	Town of Blackfalds
Wells, Rick	Elizabeth Metis Settlement
Westerbeek, Ed	City of Calgary
White, John	Town of Granum
Whitney, John	Sarcee Developments
Wiebe, Harvey	Town of Bonnyville
Willder, Jim	Cold Lake/Grand Centre Regional Utility
Wise, Ed	Town of Penhold
Woods, Harold	Town of Gleichen
Woywitka, Bill	City of Edmonton
Xenos, Tassi	City of Edmonton
Yamishita, Allan	Town of Beaumont
Yettaw, Ken	County of St. Paul No.19
Young, Brian	Du Pont of Canada
Zacharias, Russ	Village of Consort
Zawaduk, Hank	Town of Smoky Lake

SPOUSES PROGRAM

Name	Residence
Shelley AuCoin	Grande Cache
Karen Bebbington	Devon
Anita Berreth	Acme
Shelley Braat	Ft. Vermilion
Judy Bradbury	Hay River
Sharon Brunes	Hay River
Isabel Buyar	Valleyview
Hilda Chalifoux	Edmonton
Donna Cheney	Hanna
Koreen Cummings	Mirror
Anne Dickout	Enchant
Patti Dirk	Barons
Eleanor Drinkill	Gibbons
Leanne Dyrland	De Winton
Nancy Dziengielewski	Peace River
Barb Engel	Monarch
Jean Formanek	St. Paul
Susan Freng	Coalhurst
Amberlee Gadke	Manville
Eileen Gallagher	Rosedale
Lorraine Guenther	Mayerthorpe
Dianne Harder	Vulcan
Phyllis Harris	Lacombe
Lois Hedberg	Devon
Virginia Heron	Boyle
Mary Hicks	Edmonton
Edna Janssen	Didsbury

SPOUSES PROGRAM

Name	Residence
Patricia Jeffrey	Ryley
Eileen Jones	Coleman
Lorie Kellsey	Edmonton
Glenda Kendrick	Drumheller
Irene Kerbes	Stettler
Shirly Kozuback	Rycroft
Judy Lavorato	Lethbridge
Sheila Link	Hardisty
Debbie Lyckman	Carmangay
Bev McAmmond	Edmonton
Roxanne McGinn	Edmonton
Roxanna Miller	Whitecourt
Wendi Monti	Vulcan
Janet Nicoll	Daysland
Betty Ann Peach	Hardisty
Maureen Pelkey	Wainwright
Shirley Prentice	Brooks
Carol Preville	St. Paul
Donna Pullishy	Lamont
Wendy Reinhardt	Edmonton
Vickie Richter	Picture Butte
Roberta Ridley	Chauvin
Linda Riemann	Coaldale
Dorothy Roberts	Edmonton
Lori-Anne Roberts	Edmonton
Sylvia Sawicki	High river
Shelley Sebry	Lacombe

SPOUSES PROGRAM

Name	Residence
Kelly Shepherd	Spruce Grove
Melanie Shewchuk	Nampa
Rose Songer	Grande Paririe
Shirley Stafford	Lethbridge
Sherry Still	Stirling
Paula Thoma	Fairview
Agnes Trekofski	Hays
Jan Wallace	Rockyford
Debby Wells	Red Deer
Cindy Willder	Grand Centre
Elaine Xenos	Edmonton

MANHOLE SEALING AND REHABILITATION

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INTRODUCTION

This paper has been prepared to address both the sealing and the rehabilitation of sanitary manholes, a very important segment of the collection system that has, until recently, all to often been ignored. I say both sealing and rehabilitation because while all rehabilitation work should include and result in a sealed manhole, this is not necessarily the case. This paper will discuss typical manhole defects, leakage sources and their significance, as well as the methods and products that are currently being used for sealing and rehabilitating manholes. The cost effectiveness of this work will also be discussed and an easy to use, simplified version of the life cycle costing formula will be presented.

MANHOLE LEAKAGE

Manholes were always considered to be somewhat of a forgotten part of collection system when it came to a leakage source. They were an element that had to be installed at every change in pipe size, slope or alignment and were of course, necessary for access and when backups did occur, they were the place where portable pumps were installed, but few if any people recognized them as a significant contributor of clearwater or infiltration and inflow (I/I). Attitudes began changing in the late '70's and early '80's as studies began to show the significance of manhole leakage.

The Milwaukee Metropolitan Sewerage District's 1981 Sewer System Evaluation Survey (SSES) for example, identified manholes as one of the major sources of excess I/I. Over 49% of the total identified defects were related to manholes. They represented 33% of the total maximum day I/I found from all sources.

More recently, (Almeida, 1990) stated that:

> "Past infiltration and inflow (I/I) studies have consistently shown that it is normal to expect as least 25% and up to 75% of all ground and surface water that enters the waste water system to do so at manholes."

The same magnitude of leakage was reported by (Wade, 1990) when he stated that:

> "In some studies, our findings showed more than 60% of identified I/I is derived from defective manholes."

Governmental agencies and engineers are now recognizing that large quantities of I/I can be removed from their systems economically and without the political problems generally associated with other sources, by simply sealing the manholes.

An engineering and flow monitoring firm told me that on 13 recently completed projects in Oklahoma, Arkansas, Louisiana and Texas encompassing 3.9 M linear feet of sewer, 46.6% of the rehabilitation recommendations were associated with manholes. The percentage of repairs for manhole defects ranged from 10.5% to 73.4%, with the percentage being at or above the average in 8 of the projects.

LEAKAGE SOURCES

I/I studies throughout the country have found that the defects through which leakage enters the manhole can be grouped into three major categories.

1. Cover - Direct inflow through holes in the cover and around the cover. The amount of this leakage will vary significantly depending on the depth of the surface water that is either flowing or ponded over the manhole.

2. Frame-Chimney Area - Indirect inflow, or rainfall induced infiltration, as it's also called, and in some cases, ground water infiltration through the joint between the manhole frame and chimney or cone/corbel and the chimney area of the manhole.

   Leakage of this type is not only found in manholes where poor construction practices were used or in brick manholes where it would likely be expected, but in relatively new manholes as well. This defect was originally thought to be caused by frost heave, but is now know to also be caused by:

   a) The lateral movement of the frame due to the thermal expansion and contraction of the pavement.

b) Traffic loadings, and

c) ground movement.

The source of this leakage is pavement underdrainage fed by rainfall and snow melt, entering through pavement cracks and joints, overflows through the same type of defect in surcharged storm manholes and catchbasins, and in some cases, high ground water. Manholes in grass areas are subjected to the same type of leakage from surface water and drainage swales. Settlement or dishing of the pavement around the manhole, caused by subgrade fines being washed into the manhole, is a sure sign that this type of leakage exists.

3. Structural Elements - Infiltration through defects in the main body or structural elements of the manhole, including the walls, precast barrel or cone joints, corbel and bases. These sources are obviously very dependent on the amount and height of groundwater present. Leaks of this type can wash backfill material into the manhole resulting in the creation of voids around the manhole structure.

SEALING METHODS

The importance of manhole sealing is evident by the fact that (NASSCO, 1992) devoted an entire section to it in their Specification Guidelines.

Cover Sealing - There are basically three methods available for eliminating this leakage source, all of which require accurate field measurements of the existing frame and cover and a thorough cleaning of the cover bearing surface.

1. Replace the existing cover with a new approved solid, gasketed cover.

2. Convert the existing cover to a watertight one. This is accomplished by installing a molded, high quality glued in place cover gasket between the cover and the cover bearing surface of the frame and plugging the vent and pick holes with molded rubber plugs. One of the plugs is to be removable to allow for the removal of the cover.

3. Use the existing cover in conjunction with a watertight insert that is installed under the cover and prevents the entry of water into the manhole. These inserts are typically formed from 1/8" thick ABS or polyethylene and contain one or two relief valves, lifting strap and foam rubber gasket.

Frame-Chimney Sealing - The forces acting on this portion of the manhole create a substantial amount of differential movement between the frame and chimney, which when combined with the fact that the cast or ductile iron frame and masonry chimney have different thermal coefficients and surface textures, makes this a difficult joint to seal. NASSCO addresses this differential movement problem by requiring that:

> "The seal shall remain flexible, allowing repeated vertical movements of the frame due to frost lift, ground movement, or other causes of up to 2 inches and/or repeated horizontal movement of the frame due to thermal movement of the pavement or other causes of up to l/2 inch."

All frame/chimney seals, whether they are manufactured or applied, fall into 4 categories.

1. Rigid Seal - There are four methods of providing a rigid seal, none of which of course meet the NASSCO requirement.

    a. Bolting the frame through the precast grade rings and into the top of the cone with a sealant material between the surfaces.

    b. Extending any cementitious coating or lining material used on the manhole wall up into the frame.

    c. Setting the manhole in a bed of mortar, or simply tuck pointing the frame-chimney joint with cement mortar.

    d. Encasing the lower portion of the frame and the entire chimney with a poured in place concrete collar.

All of these methods have very serious shortcomings. If the frame is prevented from moving, all of the various forces that the frame is subjected to will lead to problems with the pavement, cracking of the frame and/or grade rings or even the cone, if not, the rigid lining or mortar joint will simply crack.

2. Semi Rigid or Semi Flexible - This type of seal is obtained by applying a sealing material either to the surface of both the frame and the chimney or between the chimney or cone/corbel and the frame.

3. Flexible Membrane - This type of seal is obtained by applying an elastomeric membrane to either the internal or external surface of the frame and chimney. The performance of both of these methods are of course, totally dependent on a chemical bond to each of the dissimilar surfaces.

4. Flexible Rubber Manufactured Seal - This type of seal is premanufactured for the purpose and installed either on the inside or outside of the frame-chimney joint area by either expanding or tightening corrosion resistant compression bands. The seal is therefore not dependent on a chemical bond and has the ability to remain watertight while allowing the frame to move in response to the varying forces that it is subjected to.

The most popular and commonly used manufactured seal was developed on 1980 and first installed in February of 1981. This seal was proven to be an extremely effective product, as tens of thousands have been installed since its introduction. It is the most cost effective and longest lasting of the various methods that have been tried over the years and meets or exceeds both the material and performance requirements of the NASSCO specification.

An indication of this durability and longevity was evident in the 2/93 inspection of one of the original 2/81 installations. While the seal looked pretty dirty, it looked great after cleaning. After 12 years of use, it looked as good as if it were brand new.

The cylindrically shaped sleeve has finned sealing sections and an expansion band recess on each end, separated by a double pleated center portion. This shape allows for differential vertical and lateral movement, without restricting manhole entry and without stretching or straining the rubber.

These internal seals can be installed in brick manholes in generally less than 45 minutes and in precast manholes in 15 - 20 minutes. Higher chimneys in precast manholes can be covered by adding interlocking, rubber extensions to the seal.

Manholes with excessive frame offset or badly deteriorated chimneys require excavation to allow the necessary repairs to be made. In cases such as these either an internal seal can be installed after all the work is completed, or an external seal can be installed prior to backfilling. To be effective the external seal must be able to be mechanically locked onto the frame.

It is important that both of these seals be designed so that the necessary movement can be obtained with little if any stretching of the material. Repeated stretching results in a reduced service life and the forces required to accomplish the necessary movement could result in joint separation below the seal.

The external and the internal manufactured seals are both included in the NASSCO specification, so the user must decide which to use.

Structural Element Sealing - Chemical grouting is one of the most commonly used methods for sealing both isolated and more wide spread leakage and for filling exterior voids around the base, walls and corbel of structurally sound manholes. The success and long term performance of this method is totally dependent on the type of grout used and several other factors, the most important of which are grouting procedures and workmanship.

When it becomes necessary to virtually encapsulate a brick or block manhole to seal extensive leaking, it is generally more effective and economical to apply a cementitious coating to the inside of the manhole prior to injecting the grout to prevent it from migrating back into the manhole.

Manholes that show little or no evidence of movement can also be sealed and rehabilitated through the use of a cementitious patching and coating system, which will be discussed in the rehabilitation section. The structural and structural enhancement lining system discussed in the rehabilitation section also of course, provide sealing.

Precast Joints - There are basically 4 different methods typically being used to seal leaking precast manhole joints, which is often a very difficult and time consuming procedure.

1. Chemical Grouting - Drill holes and inject chemical grout around the outside perimeter of the joint.

2. Cementitious Materials - Widen the joint and patch with a hydraulic cement or patching mortar alone or in conjunction with lead wool or oakum.

3. Expanded Gasket - Widen the joint and insert dry twisted jute oakum or resin rod, soaked with water activated polyurethane resin.

4. Manufactured Seal - Install a manufactured joint seal similar to the frame-chimney seal with an added stainless steel restraining hoop. This is a mechanical seal that is not dependent on a chemical bond and has the flexibility to allow the manhole sections to move independently of each other.

REHABILITATION

Manhole rehabilitation includes both the rehabilitation and sealing of all of the elements of the manhole, using various products and procedures either singularly or in combination. All rehabilitation projects should address the following:

1. Sealing, Plugging, Patching and Coating of the Manhole Structure.

2. Repair or Rebuilding of the Manhole Chimney and Corbel.

3. Removal and/or Replacement of Unsound and Missing Steps.

4. Realignment or Replacement of Manhole Frames and Covers.

5. Lining and Structural Enhancement.

6. Frame Sealing.

7. Cover Sealing or Replacement.

8. Final Acceptance.

Sealing, Plugging, Patching and Coating - To insure proper performance of any of these types of surface bond dependent materials, whether it's cementitious, epoxy or plastic, it is absolutely necessary that all surfaces be cleaned and all loose bricks, mortar, unsound and weak concrete, grease, laitance and other materials be completely removed.

Water blasting with a gun or a double jet wand, is typically used for this purpose. There is some controversy as to how much pressure is needed to properly clean the surface. Some say that 1500 psi is enough, while others advocate 10,000 or even 20,000 psi. Wade, (1991) claims that the minimum pressure should be 5,000 psi. He claims that this much pressure is necessary to etch the brick surfaces, which provides a mechanical as well as chemical bond. It is his opinion that the past failure of some of the cementitious coating systems was due to cleaning with too little pressure and the fact that a mechanical bond was not provided. There are those however, who claim that 2,500 psi is adequate. It is physically impossible for any of these products to function as intended if the surface is not properly prepared, so unless proven otherwise, I don't think cleaning at pressures below 5,000 psi is worth the risk.

After this thorough cleaning, all active leaks are either sealed or channeled through bleed pipes drilled in the bottom of the manhole. All large holes or voids around steps, joints, or pipes, and all holes caused by missing or cracked brick, are patched and all missing mortar repointed using a non-shrink patching mortar.

One of the most commonly used methods of rehabilitation and sealing manholes involves the use of cementitious patching and coating materials. Two coats of a liquid polymer modified hydraulic waterproof cementitious coating material is either brush or spray applied. The grey coat is normally applied first, followed by the white. Two coats is claimed to prevent leakage from a 16 foot water head, while three coats are claimed to provide protection for over 100 feet of head. The completed manhole not only looks good, but will provide many years of leakage free service.

Corrosion protection coatings can either be applied over these cementitious coatings or as an independent coating system. These systems generally consist of 1/8" thickness of either brush or spray applied epoxy mortar or spin cast applied epoxy or polymorphic resin. All of these systems claim to provide an impermeable, permanent water barrier which has outstanding chemical resistance.

Lining - The various types of lining products and procedures fall into two broad categories.

Stand-Alone Lining - a stand-alone lining is one that is not dependent on the existing manhole for its structural integrity. There are two basic types of this lining.

1. Poured-In-Place Concrete - This method utilizes an internal segmental forming system for casting a structurally independent 3" concrete wall inside of the existing manhole. The liner is constructed of high strength concrete in one pour, without seams and without disrupting sewer flows.

   Because this liner does not depend on surface bond it is only necessary to remove any loose material from the existing manhole and stop only that leakage that would adversely effect the poured concrete. The inlet and outlet pipes are extended through the forms so all flows through the manhole remain active.

   The wall thickness of the new liner may decrease to l-1/2" at the top of the cone/corbel and through the chimney.

   The concrete typically used is a 6 bag Type II mix with a 3/4" minus aggregate producing a minimum 4000 psi compressive strength. High strength quick setting cement grout is generally used for positioning and sealing the form at the base.

   If corrosion protection is needed, it can be provided by either special coatings, PVC sheeting or by using concrete made with special cements or additives.

   There are 2 new cast-in-place lining systems currently on the market that also utilize an internal forming system. One utilizes a high strength concrete that is claimed to have twice the compressive strength of ordinary concrete, which therefore allows it to be installed at half the thickness that concrete normally requires. This material provides a high density, low permeability structure that may be suited for certain industrial environments. The other utilizes a 2 component, 100% solids epoxy system designed to produce a pourable concrete like mixture when combined with selected aggregate materials. The performance characteristics show that the material attains a 24 hour and 7 day compressive strength of 8,000 and l2,000 psi, a 7 day tensile strength of l,400 psi and provides very good corrosion resistance.

2. Prefabricated Fiberglass - This method involves the excavation and removal of the existing manhole frame, chimney and corbel/cone and insertion of a pre- fabricated glass fiber reinforced manhole liner and cone section.

   The bottom of the liner is cut to fit the existing manhole base and the inlet and outlet pipes are extended through the liner. The bottom of the liner is sealed and positioned using a quick setting grout.
   The annular space between the liner and the existing manhole is filled with a 4 bag cement and sand grout.
   The manhole chimney is then constructed on the flat top shoulder of the liner and the manhole frame and cover installed.

Structural Enhancement Lining - This type of lining restores the structural integrity of the manhole and provides varying degrees of corrosion protection, but it's performance is totally dependent on either bond to the surface of or support from the existing manhole. It is therefore absolutely essential that the surface of the existing manhole be cleaned to the same degree of thoroughness as discussed earlier for coatings.

1. Cementitious Lining - This method uses a premixed cementitious blend of binders, materials, aggregates, glass fibers and other additives, that is spray applied directly to the manhole surface.

   Specially formulated prepackaged mixes, containing fiber reinforcement and special additives that produce a non-shrink finished product with a 28 day compressive tensile and flexural strength of 3,000, 300 and 600 psi respectively.

   It is necessary to stop all active leakage and patch all large voids prior to applying the material. The material is then spray applied directly to the damp manhole surface in a 2 coat operation, with in between and finish troweling required. The material must completely cover the interior surface of the manhole with a minimum total finished thickness of 1/2".
2. Profiled PVC Lining - This method consists of installing interlocking ribbed unplasticized/rigid PVC (UPVC) panels or coils in an existing manhole. The liner is then strengthened and supported with cement grout, which is injected into the annulus between the liner and the existing structure. The barrel section is lined with either panels or

coils that are helically wound around the interior of the manhole, snapping the interlocking edges together as the lining proceeds up the manhole. Strips are fastened to the wall prior to installing the liner to avoid discontinuities in the wall surface and to provide for the grout annulus. The cone/corbel lining is accomplished by inserting truncated pie shaped panels with interlocking edges.

3. Cured-In-Place Fabric Liner - These system involves either the installation of a resin-impregnated flexible felt tube that is inverted into the existing manhole using hydrostatic pressure and cured with hot water or a fiberglass cloth tube impregnated with epoxy resin, expanded into place with an air blower and cured with hot air.

   In both cases, the material is fabricated to a size and shape so that when installed, it will neatly fit the interior of the manhole. The interior of the manhole is to be cleaned as noted previously, all obstructions and manhole steps must be removed and all large voids filled prior to installing the liner.

Manhole Frame-Chimney Joint - Regardless of what type of lining system is used, it is necessary to provide a flexible watertight seal between the manhole frame and the new lining.

COSTS

All of the products and methods that we have looked at have various capabilities, limitations, service life expectancies and costs. Once performance requirements are set, the only way to determine the most economical method or product is to look at each one's total effective or true cost over a comparable service or performance life. When conditions require a chemical or hydrogen sulfide resistant coating, you can not compare the initial cost of a resistant coating with one that is not, because of drastically different performance and service lives. Likewise one can not compare the initial cost of a sealing method that may only have a 5-6 year service life with one whose service life is 25 years by simply comparing the initial cost or bid price of each.

The simplest, most straight forward and accurate method of determining these costs is through a least cost analysis. Prior to actually performing this analysis, it is first necessary to determine the desired design life and the service life of the alternate sealing or rehabilitation methods being considered. (Kerr and Ryan,

1986) state that the effective cost of each alternate is obtained by adding the future cost of replacement to the initial cost of the shorter lived methods and subtracting any savings in interest costs over the same period. Replacement costs are determined by the number of replacements of the shorter lived methods required over the life of the longer lived one, the cost of replacement and the expected inflation rate over the period.

For the sake of this paper we will set the design life at 25 years. The effective cost of each alternate method will therefore be it's bid price or initial cost plus the total of the present values of all replacement costs over 25 years, adjusted for inflation. Equation 1 presents the generally accepted formula for calculating this effective cost. It includes both an inflation factor, which converts the initial cost to future replacement costs, and the present value factor, which converts future replacement costs to current dollars.

$$EC = P + (PxIFxPVF) \tag{1}$$

where:

EC = Total Effective Cost (current dollars)
P = Bid Price or Initial Cost (current dollars)
IF = Inflation Factor
PVF = Present Value Factor

$$IF = (1 + I)^{n} \tag{2}$$

$$PVF = \left(\frac{1}{1 + i}\right)^{n} \tag{3}$$

where:

I = Inflation Rate (%)
i = Interest Rate (%)
n = Service Life (years)

Substituting the terms from Equation 2 and 3 and simplifying, Equation 1 becomes:

$$EC = P\left[1 + \left(\frac{1 + I}{1 + i}\right)^{n} + \left(\frac{1 + I}{1 + i}\right)^{2n} \cdots\cdots + \left(\frac{1 + I}{1 + i}\right)^{mn}\right] \tag{4}$$

where:

m = The total number of times the method has to be redone

This form of the equation looks very intimidating and while usable, requires assumptions of future interest and inflation rates, which could vary widely. Kerr and Ryan state however that the absolute levels of interest and inflation are less important to the analysis than is the differential between these rates and therefore recommend that this relatively stable differential be used in a least cost analysis. Utilizing a range of interest and inflation rates, the minimum, average and maximum of the interest/inflation rate factors were obtained. A table was then prepared utilizing the average value of these factors, raised to the or power for a number of service lives for each of five differentials, which simplifies the use of the equation.

(Odill, 1992) simplified the equation even further by breaking it into two parts, the bid price or initial cost and a multiplier, which he called an equalization factor (EF).

$$EF = 1 + \left(\frac{1+}{1+i}\right)^{n} + \left(\frac{1+}{1+i}\right)^{2n} \cdots\cdots + \left(\frac{1+}{1+i}\right)^{mn} \qquad (5)$$

The effective cost of each alternate method then becomes:

$EC_A = PxEF$

Equalization factors, based on a 25 year design life have been calculated for service lives of 2, 5, 8 and 12 years. These factors are presented in the following table.

Equalization Factor
(25 Year Design Life)

i-I %	Service Life (n) Years			
	2	5	8	12
1	11.690	4.578	2.795	1.897
2	10.551	4.204	2.613	1.804
3	9.661	3.909	2.466	1.729
4	8.782	3.613	2.318	1.652
5	8.092	3.379	2.199	1.590

To use this table it is apparent that the choice of a proper interest/inflation rate differential becomes an important factor. For state and local government agencies Kerr and Ryan recommend that the historical difference between the municipal bond rate and the producer price index (PPI) be used. Based on the average of these differentials, it appears that a 2 percent differential is the appropriate value to use for a least cost analysis of this type.

The effective cost of various alternate sealing or rehabilitation methods with different service lives can be determined very easily by multiplying each method's bid price or initial cost by the appropriate equalization factor from the table. An example of this would be the comparison between Method A, with a service life of 8 years, which was bid for $500 and Method B, with a service life of 25 years, which was bid for $1000. The difference between the two is not what it seems, for while the bid price of Method A is only half of that of Method B, it's effective cost ($500 x 2.613 = $1307) is actually 30 percent higher than that of Method B.

This simple calculation allows the community to make a much more informed decision in deciding which method to use.

CONCLUSION

I certainly hope that this paper has given you a better understanding and respect for manholes. Existing ones can no longer be ignored and new ones can no longer be built and forgotten as they used to be. Manholes are a very important part of the sanitary sewer system which do and will allow the entry of huge quantities of I/I, I/I that is not only expensive to pump and treat, but robs the system of capacity that could be used for new development. So when looking at your system, don't forget the manholes and whether you are planning to rehab them or build them new, remember to address the entire manhole, not just part of it.

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Planning Strategies for Variable Conditions

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Introduction

Most of us here have had situations that just seem to "crop up" for no apparent reason. Somewhere from the extreme, like an impaired driver who runs into the back of your car while you're on vacation, to the simple things, like running out of gas on the way home from work. Many of these situations don't normally happen, mainly because on a day-to-day basis we prepare for the unexpected, well, at least the things that we have control over. For example, if you are supposed to bring home some groceries on Thursday night because friends are coming over for supper, ten to one you'll probably write it in your day-timer or somewhere that you'll likely see it, and of course, it will be remembered. Quite simple, isn't it?

Over the last few years now, we have heard about how **NOT** to bring our work home with us. The main reason is that it may cause undue stresses within the family structure. Let's try reversing this situation a little bit. We attempt to keep our home life quiet, stable, relaxed and somewhat organized. What changes would happen if we brought this attitude to work with us. You've probably experienced that at on some job sites there are one or two very harried employees. They run around attempting to get work done, but there is no organization, planning, control or discipline to their working habits. These people usually have a tendency to get behind on their job functions, often are late getting to work, and many times, seem to slow everyone else down in the jobs they are trying to do.

The attitude displayed by this type of person is the basis of this presentation. Through adequate information, planning, examples, communication and training, we can learn how not to be in this unreasonable state. Within the Water and Wastewater industry, we are professional, quality orientated individuals who are mostly in a Civil Service environment. As Civil Servants, we are the care givers to our Municipal populations. We usually work with variables that change on a seasonal basis, such as spring run-off conditions in a river supply, to unforeseeable problems like equipment failures or pollutants within our processes. These variable are the things that we have to be most prepared for, on an ongoing basis, to be able to provide our customers with the best possible and regulated product or service.

Concept Overview

Some of the items that I'm going to talk about are probably thought of an a day-to-day basis, but what I'm hoping for, is that some of these ideas will promote an after thought, items that will add to your normal way of thinking.

This concept is being proposed for use by all employees. The strategies that I am proposing start at all levels of our jobs and we have a certain responsibility to carry out these functions. This is in part a major factor of pro-active problem solving, and if we want to do our jobs well, we must be involved. Support is definitely required at all levels, from on-line operators to General Managers; we should support each other for the common goal of doing our jobs correctly, efficiently and safely.

Main topics of this presentation will include gathering facts and information, forecasting, situation profiles, motivation, preparing action plans, planning, communication and training. I will be using a specific situation, as a referral point, regarding spring run-off conditions causing variables in the North Saskatchewan River. This example situation is being used because I am personally familiar with it, but it can be easily changed to suit any of your own utilities or work sites. For a moment, stop and think of a situation that occurs where you work, that you think would have better end results if something was done differently. Whenever I discuss about the North Saskatchewan River, try to subsisted your own situation.

Presentation

In starting this presentation, I would like to briefly describe the process of Edmonton's Water Treatment facilities. This can help you to understand the overall situation of what is to be dealt with when planning strategies to effectively organize a large scale system. The process of planning these strategies will be the same for dealing with all variable conditions, no matter what the size of installation or type of operational process.

The Rossdale and E.L. Smith Water Treatment Plants are responsible for producing a high quality potable water product to meet the demands of the City of Edmonton and surrounding areas.

Edmonton's water source is the North Saskatchewan River which rises in the Columbia Ice field and is fed by a number of tributaries including the Clearwater, Brazeau and Nordegg Rivers. It is characterized by it's heavy silting particularly

during the annual spring run-off and in periods of heavy rain. These factors make the river susceptible to extreme and rapidly changing water conditions and consequently place a heavy demand on our water treatment system.

In 1991 during the typical run-off months of March and April, the Class 4 Water Treatment plants in the City of Edmonton produced 18,981 mega litres of potable water, using approximately 3.3 million kilograms of process treatment chemicals, supplying a total approximate population of 767,665. During this time period, the North Saskatchewan River was quite erratic with higher concentrations of volatile organics which were less than 150 parts per billion, raw turbidities of over 2000 National Turbidity Units and high colour values of in the mid thirty range. If you are not familiar with actual water treatment processes, these types of supply variables which were consistently changing, make it extremely difficult to produce a quality potable product.

Water enters the Rossdale and E.L. Smith plants through ten low lift pumps. Travelling water screens in the intake ducts prevent large debris, such as fish, twigs and rocks from entering into the plants. Edmonton's Water Treatment system is a multistage process. It consists of primary and secondary clarification, followed by recarbonation, disinfection and filtration. The residence time of the water in the treatment process is approximately eight hours, depending on the average intake flow rates. Lab tests are performed on an ongoing basis to ensure that the resultant potable water quality meets the fifty-two criteria stipulated in the Guidelines for Canadian Drinking Water quality standards. The treated water is carried through the City's distribution piping network by use of up to six high lift pumps. The water pressure is maintained by these pumps to meet consumption requirements and the fire department criteria. Excess potable water that is produced by the plants may be stored in ten reservoirs located throughout the city. The water is pumped from the reservoirs by additional pumps as the supply demand increases.

Gathering Facts

Forecasting is looking forwards toward the future with the eyes of today.

One of the many things we should consider when gathering facts to identify variable conditions, is to really understand how our whole system works. You have to look into all aspects, any possible variances, and look to the future for growth and changes. A very important consideration to remember is the fact that accurate files and records of information have to be kept. If at all possible, logs on an

hourly, daily, weekly, monthly and yearly basis should be available for review and analysis. This information would also be of a great benefit incase of any possible legal actions if an adverse situation happened to occur. Proper storage of these records are extremely important. Established policies, procedures and methods will also have to be considered.

This is where we, as the workers of the systems, will probably have the greatest input. This is also a main point in what I mentioned earlier about "support". All to often this can be a stumbling block in many organizations. There seems to be an incredible division between the "workers" and the "Management". In the Water and Wastewater industry this may not be as apparent as in larger corporations. In many instances, especially in the smaller Municipalities, there are only one or two people who operate the plant functions and make the majority of on the spot decisions.. There are usually no divisions in this situation, only teamwork to get the job done.

When working as a team, we can draw back on past experiences and working knowledge to suggest additions, improvements, probable variances or problems, preventive maintenance programs and are aware of older equipment that could cause future troubles, especially during upset conditions. For example, with the great variances in the North Saskatchewan River during spring run-off, we know that there will be increased chemical usage, equipment will be under intensive demands, staffing will have to be at a premium because of increased work loads, there has to be a budget to cover all of these short term changes and the plant process should be reevaluated due to the different reactions of the chemicals under extreme conditions.

Using these experiences we can access the future. You can see what has happened in the past, the probability of what may or may not happen again and predict with very good accuracy of what probably will happen in most future instances. Re-evaluate the normal way you think of things. We have a great tendency to follow established and traditional ways of our work functions. There is nothing wrong with tried and true methods, but by staying within this thought process, we can miss alot. A long time ago I read an article on this subject and a part of it stayed with me. It said something like this, "the changing workplace has led us to realize that our traditional tool boxes must now contain some non-traditional equipment." So, when forecasting, consider what could happen and use an open mind.

Another relatively new concept for identifying possible variances or weakness of a system, is to establish a Process Development Team. This team or group of people could be responsible for reviewing existing plant functions, research and development of design, construction and site development, expenditure reduction planning, effective and efficient chemical usage control, quality assurance provisions and Capital projects. The Process Development Team (P.D.T.), does not necessarily have to be complied of experts from outside of your normal work site, it could easily be of senior, experienced personnel, who are willing and dedicated to assist in the system growth. By using existing on site personnel on a term project, additional part-time or temporary staff could be hired, which in turn would allow more flexibility of manpower for vacations, sick time and training.

Planning - Preparing Action Plans

Planning gives direction, improves continuity of action, and reduces overlapping and wasteful activities. This makes it possible to anticipate change and develop alternatives, give functional operation through clarity of purpose thereby reducing wasteful duplication and allows for performance standards by which the alternatives can be measured. Planning is to decide what to do, how to do it, and know who is going to do it. When we are aware of possible variable conditions, we should have a plan to either rectify the upset situation or have an action in place to allow us to compensate for the variable.

Considering that we have identified situations that are to be addressed prior to them happening, it is time to plan for these changes. Planning requires the determination of your actions in advance. You decide what to do, establish objectives, sub-objectives and formulate forecasts. Before planning and initiating any course of action, objectives must be clearly determined, understood and stated. Objectives are the ends towards which all activity is directed. Thorough planning should include the expectation of changes, action to these situations, establishing priorities, setting target dates for implementation of plans and adapting your system to meet the new variables. With these main ideas, plan your action and decide on adequate training that would be required. If at all possible, consider the act of long range planning, lets' say for approximately two to three years ahead. This will allow some flexibility with budget, manpower and system controls when you anticipate and can verify the need for these services. It is important to also establish emergency procedures to meet with possible planning deficiencies.

Planning for variances within the quality of the North Saskatchewan River is a major task. A review of all documentation, procedures and chemical usage over the last number of years is required to accurately decide a plan of action to take. Approximately one month prior to the actual run-off period, Edmonton's Water Branch re-establishes procedures regarding the river changes. These procedure modifications have been researched, tested and developed since the last run-off incident. New technologies in the field of water treatment are ever advancing and traditional methods of operation can be improved upon prior to adverse situations.

Process directives are issued to remind and inform all associated personnel of the impending river quality deterioration. This involves the Maintenance Department to adjust to the fact of heavy workloads on the existing equipment and that uninterrupted continual usage is required; the Laboratory to increase testing of the raw water for volatile organic compounds which increase spring taste and odour concerns; the Plants' Engineering Group to ensure that new upgrades of equipment and computerization is complete, tested and functional; the Operations Department is informed and trained on new strategies for effective chemical dosing, upgraded procedures, trained on new analytical devices and are knowledgeable of indicating factors for run-off conditions.

With this type of advance planning, variances within the North Saskatchewan River which affect the treatment of this supply, can be handled well with only minimal consequences being identified. Things can and probably will go wrong even with the most intricate planning methods for variable conditions, but this allows for improvement of future control over these situations and provides valuable hands-on experience for strategy planning.

Situation Examples - Profiles

A Profile is simply a real life occurrence. We have determined what to do and how to do it, now it is time to set up examples of situations and evaluate their actual effectiveness. At this point, it is important to reconsider our current program status and implement any changes that are necessary to upgrade to our new strategies. During this situation example process, it is imperative that an unbiased evaluation of all variances are observed, so that you may arrive at an optimum performance level for the planning strategies you wish to accomplish. Evaluation is a performance measure comparing to a known standard.

Setting up profiles will entail asking a great number of questions. You will have to ask yourself, "what if..." on almost every known circumstance that you wish to profile. You are now putting together all the information, concepts, accumulated knowledge, past experiences, and probabilities into one practical example. This is where we are able to prove first hand, that all the planning and forecasting will actually work.

Consider building a toy model airplane. In front of you are a thousand intricate pieces ready to be placed together, there are instructions on how to complete the building process, and even a picture to show what the end result is going to be. Usually all the pieces fit, some may require slight modifications while you are putting it together, and in the end you have a replica of an actual airplane.

This procedure is almost the same for modelling strategy variables within a system process. Models assist us in the understanding of complex relationships by simple visualizing a complicated process and having an end point quantity. Models can be used to accurately picture an action. The information is gathered together, variables are identified, plans are available for building onto the structure and a situation is formulated into a practical working strategy. If modifications are required, this is the opportunity to identify them and revise as necessary.

Earlier on in the presentation, I mentioned about the Process Development Team and their usefulness in identifying future concerns and possible system weaknesses. While setting up system profiles and modelling, a team of this type could play a very important roll. Being that the P.D.T. are not directly required to operate a specific day-to-day function at the work site, they would be running test, establishing the validity of new or old methods in existing procedures and are physically on site to review equipment and its operation. With the budget luxuries and a real concern regarding potable water, a large municipality like the City of Edmonton, has been able to set up a P.D.T. to improve our existing systems. This team built a pilot plant on-site and experiments daily with the raw water, accessing known and unknown variables. A down sized scale model was built of a water treatment plant and as technology permits, new ideas are being used to reduce variable raw water conditions and optimize presently used chemical treatment processes.

This team has directly increased the quality of our treated water and has reduced wasteful expenditures of overuse regarding chemical treatment. There are definite benefits in the use of this team concept.

Getting Results

The preparation for strategy formulation should now be quite complete and it is time to see the results of all your fruitful works. A few key issues that have now to be considered are Motivation, Communication and Training. Simply put, motivation is the ability to move people into action; communication is the art of achieving understanding among people, and training is the application of knowledge. Information has been gathered, action plans are prepared, profiles are complete and now is the full implementation of the program into your system.

Communication and training are the major aspects of this final stage. Effective communication increases the probability of being successful in any given project, better work will come about from better understanding. Considering the new strategy will most probably affect everyone at the work site, the complete chain of command will have to be notified, using proper protocol and insuring you have a workable program that will bring about the desired results. Your program information will have to be communicated to all employees and should not just deal with overall benefits and objectives, but should identify specific objectives and benefits which concern all parties involved. The information must be in an understandable format not allowing questionable conditions to arise. One of the key elements to successful communication is feedback. It verifies that the ideas you have stated were understood.

Training of personnel is now required. We should identify the learning capabilities of our trainees, clearly specify objectives that the trainee must be able to do after the training period, plan the training sessions, including follow-up procedures, give demonstrations, have formal documentation of what is to be taught, and finally conduct question and answer programs to ensure that what has been taught is fully understood by the trainees. These are some very basic rules for training. The art of effective training is quite complex and this subject alone could easily be the basis for another whole presentation.

The strategy is now ready for implementation on a full scale. Information is intact, your action plans are prepared, profiles have been evaluated and everyone knows what the strategy is and how it is to be accomplished. With a large Water Branch, such as within the City of Edmonton, we have found that process/distribution directives accomplish "putting into action" most new strategies. These directives allow written instruction of information and hard documentation for referral. A recent directive that was issued, was regarding spring run-off protocol updates. The directive included revised actions that are to be taken regarding chemical

dosage adjustment, clarifier sludge blanket optimization, the commissioning of a polymer feed system that had previously been used on a trail basis and finally a reminder of disinfection quality standards. A directive of this volume may seem quite ominous if all other aspects of strategy preparation had not been adhered to, but with adequate information, planning, modelling, past communication and on-going in house training programs, this type of directive is accepted, understood and placed into immediate practice.

Conclusion

Over this last little while, I have attempted to presented to you an accurate number of ideas and issues involved in planning strategies for variable conditions. As I stated at the beginning of this presentation, these ideas are meant to help you expand upon your own knowledge in setting up effective and efficient programs. We looked into accurate gathering of facts, research and development, action plans and how to get results. We have also explored the concept of communicating and functioning in an orderly, organized manner while establishing and completing realistic objectives.

ONE CALL SYSTEMS

Robert R. Chisholm, P. Eng.
General Manager
Alberta One-Call Location Corporation

1.0 Introduction

Although underground public works systems have existed for centuries, the creation of an underground infrastructure to serve the general population is a modern development. Underground facility networks are becoming increasingly more complex. Every day more and more facilities are buried as we develop and redevelop communications, energy and material transportation and distribution systems in both urban and rural settings.

Consider your own property. Do you know what is buried on it? Do you know ***exactly*** where it is buried? Expand your viewpoint from your residential lot to your subdivision, your city, your province, the country. It is almost inevitable that what one man has buried, another is sure to dig up!

2.0 Damages To Buried Facilities

Damage to a buried facility is often referred to as a "hit" which is defined to be "physical damage to a buried facility caused by unauthorized contact which results in a cost or a service disruption".

Consider the possible consequences of a hit.

- loss of life
- personal injury
- environmental contamination
- evacuation of residential areas
- third party property damage
- disruption of essential service
- inconvenience to facility customers
- loss of product
- loss of revenue to facility owner
- costs to repair damaged facility
- costs to rehabilitate injured workers

- costs to rehabilitate environment
- police, fire department and ambulance costs
- lawsuits
- medical costs
- legal costs
- administration costs
- increased WCB assessments
- increased insurance premiums

The investment in our underground infrastructure runs into billions of dollars in most provinces. As individuals, we have become more and more dependent on this infrastructure and buried facilities have become essential services in our everyday life.

3.0 One - Call Systems

In response to the increasing instances of damage to buried facilities, a cooperative effort of utility owners and the construction industry led to the establishment of the first one-call system in Rochester, New York, in 1964. The success of this system has led to the formation of one-call systems around the world.

Today, all states in the USA except Hawaii, North Dakota and South Dakota are covered by one-call systems. Forty-one states have legislation related to membership in and use of one-call systems.

Progress has been slower in Canada. In Ontario, there are three or four systems each covering a specific municipality. Alberta has the only province wide one-call system in Canada.

3.1 What Is A One - Call System?

A one-call system is a communication system that allows anyone who wishes to excavate within the "service area" of the system to notify, through one telephone number, the owners and operators of buried facilities who are members of the system, of his or her intent to excavate and to request that those owners and operators of buried facilities identify and mark the location of their facilities in the area of the proposed activity.

This is a generic definition which must be modified from system to system to address the specific needs and concerns of the particular service area.

Yet a one-call system must be more than this. It must encourage use of the system by the digging community and it must acquire members, those who own or operate buried facilities. It must be a communication link, a damage prevention system and a safety program.

3.2 Advantages Of A One - Call System

A one-call system offers advantages to both the facility owner and the digging community.

The primary advantage is a reduction in damage to buried facilities. As a consequence, reductions in personal injuries, service disruptions and loss of product can also be expected.

A one-call system offers facility owners the opportunity to standardize methods and procedures with respect to information required from the excavator, field marking of locations, buffer zones, locate slips and damage report forms.

For the digging community, a one-call system simplifies the procedures for having buried facilities located. It is time consuming and may be difficult for an excavator to contact the right person from each facility owner. Different facility owners may require different information with respect to the proposed excavation.

The single telephone number of a one-call system offers immediate response to a locate request. It reduces the time spent on hold, being transferred and the overall time to arrange for locates for the excavator.

The advance notice requirement of most one-call systems allows facility owners sufficient lead time to efficiently schedule and dispatch locators and gives the excavator a better idea of when locates will be done.

A one-call system provides members with the vehicle to present the unified front of an association-like nature and increases the effectiveness of public awareness and advertising programs.

3.3 Objectives Of A One - Call System

A one-call system, once in operation, becomes a multi-faceted vehicle with potential benefits for the entire community.

A well organized and well operated one-call system can be expected to accomplish many things.

- reduce personal injuries
- reduce damages to buried facilities
- reduce overall facility repair costs
- reduce disruption of essential services
- reduce excavator downtime
- reduce environmental contamination
- increase public awareness of the inherent dangers in disturbing the ground
- increase the number of locate requests
- improve relationships between the digging community and the owners and operators of buried facilities
- improve cooperation among the various owners and operators of buried facilities
- provide economies of scale and consistency of messages in public awareness and advertising programs

4.0 Alberta One - Call Location Corporation

4.1 Background

In the late 1970's, Alberta experienced unprecedented economic growth, primarily due to the development and expansions of energy related industries. This growth, together with the intense construction activity in both rural and urban Alberta, created a severe risk of personal injury accidents from an alarming number of damages to buried facilities.

In 1979 alone, excavation activities in Alberta caused over 8,600 damages to buried facilities with direct costs in excess of $4 million just for damage repair and loss of product. This sum does not include the costs incurred through loss of service, liability for property damage, personal injury, legal fees or administration.

The most severe incident occurred in Millwoods, an Edmonton subdivision, on March 2, 1979. Propane, leaking from a damaged pipeline, ignited, forcing the

evacuation of 18,000 residents and almost costing Peter Clark his life when his vehicle was engulfed in the fireball. This disaster was a major factor in the decision to implement a province wide one-call system.

4.2 History

Through the initiative of the Energy Resources Conservation Board and with the support of the Alberta Chapter of the Canadian Public Works Association, the Alberta One-Call System Committee was formed in September 1979 to investigate and prepared a feasibility report on the implementation of a one-call system in Alberta. The Committee comprised representatives from provincial, municipal, utility, pipeline and construction agencies.

The Feasibility Report published in December 1980 recommended the establishment of a one-call system. Alberta One-Call Location Corporation was incorporated on 25 August 1982 as a non-profit corporation with twelve shareholder members, who provided the seed money to implement the system.

4.3 Evolution

Alberta 1st Call, as the Corporation is better known, began operations on 1 October 1984, utilizing a USA based sub-contractor for provision of the complete system and service.

In 1988 the Corporation purchased a computer and arranged for the provision of a software package. On 1 October 1988, Alberta 1st Call became a complete in house operation.

Today, Alberta 1st call has 13 shareholders, each of whom appoints a Director to the Board. The Board of Directors, through a four person Executive Committee, entrusts the operation of the call-centre to the General Manager and his staff.

4.4 Mission

It took Alberta 1st Call several years of operation to fine tune its self-definition into this mission statement.

> "Alberta One-Call Location Corporation, a non-profit organization, will provide an effective communication system between those who wish to

disturb the ground within Alberta and those owners and operators of buried plant in Alberta, who are members of the Corporation.

The Corporation will recruit members, promote the service it provides and promote public awareness of the need to "Call Before You Dig" to minimize the number of unauthorized contacts with underground facilities thereby reducing personal injury or property damage."

This statement addresses the specific organization of Alberta 1st Call and provides direction for its activities.

5.0 What Impact Has Alberta 1st Call Had?

Since it began operations in 1984, Alberta 1st Call has experienced significant growth in all its activities and progressed toward the achievement of its mission.

5.1 Effective Communication System

Alberta 1st Call provides a toll free telephone number (1-800-242-3447) that allows anyone planning to disturb the ground in Alberta to communicate a request to the owners and operators of buried facilities in the province, who are members of Alberta 1st Call, that the location of their buried facilities be marked prior to excavation.

There is no charge to the caller for this service. Members of Alberta 1st Call are charged a nominal fee for each locate request transmitted to them. This fee is currently less that 50% of what it was in 1984.

Recently ★ 3447 has been introduced by all the cellular networks as a no airtime charge access to Alberta 1st Call for their customers.

5.2 Member Recruitment

Membership in Alberta 1st Call has increased from 12 in 1984 to 200 as of 31 December 1992. Figure 1 shows membership status at 31 December of each year from 1984 through 1992.

Potential membership is of the order of 950 owners and operators of buried facilities, many of whom are very small. Current membership is responsible for the vast majority of the buried facilities in Alberta.

Membership is voluntary. Legislation to include mandatory membership may be considered at some time in the future. Such legislation would be supported by the digging community.

5.3 Promotion Of The Service

A combination of increasing public awareness of the need to "Call Before You Dig" and increasing membership has led to an increase in locate requests from 74,080 in 1985 to 129,749, an average annual increase of 8.34%. Figure 2 shows locate requests for the period 1985 through 1992.

5.4 Promotion Of Public Awareness

Alberta 1st Call spends more that $350,000 per year on advertising and public awareness programs. Many vehicles have been and are being used to carry the "Call Before You Dig" message.

Television, cable TV information channels, radio, newspaper, billboards and busboards have all been used for mass media advertising programs. Our current Dangerous Weapon billboard and busboard program has been very effective in raising public awareness levels.

Promotional literature such as bill stuffers, brochures, newsletters, calendars and posters has its place in increasing awareness.

Alberta 1st Call's members' promotional activities reinforce the "Call Before You Dig" message with synergistic effects.

Attendance at conventions, trade shows, seminars, home and gardens shows and safety open houses with a display booth allows direct promotional contact with both individuals and selected groups. Seminar presentations such as today's also promote awareness.

The general public and the digging community are interested in give-away promotional items. Key tags, hats, mugs, posters, pens, refrigerator magnets, decals and wallet cards have all been used.

All these tools are used not only to develop public awareness of Alberta 1st Call and the need to "Call Before You Dig" but to sustain that awareness.

6.0 Is Alberta 1st Call Effective?

Has the existence of Alberta 1st Call reduced personal injury on job sites? Both the owners and operators of buried facilities and the digging community believe so but can neither quantify nor prove any reduction.

Has the existence of Alberta 1st Call reduced damages to buried facilities? Yes, most definitely.

6.1 Damage Statistics

Although efforts are being made to collect and interpret province wide damage statistics, getting all owners of buried facilities to report damages in a consistent manner and format is a slow process.

However, the City of Calgary Utility Coordination Damage Prevention Subcommittee has been collecting damage statistics from all owners of buried facilities within the city, since 1983.

During the period 1983-1992 these statistics show that locates done by facility owners have increased at an average annual rate of 9.45% (Figure 3) while damages have decreased at an average annual rate of 6.59% (Figure 4).

The most meaningful statistic is damages per one thousand locates which over the 9 year period has decreased at an average annual rate of 14.66% (Figure 5).

As an appropriate analogy, consider the efficiency or state of tune of an automobile on an annual basis. The number of kilometres driven (locates) as a number by itself does not provide any information relative to efficiency. Nor does the number of litres of fuel used (damages). Yet the quotient litres per 100 kilometres (damages per 1000 locates) provides a comparative index for the efficiency of the vehicle.

The decrease in damages per 1000 locates in Calgary from 24.11 in 1983 to 5.79 in 1992 demonstrates the effectiveness of the one-call system and appropriate public awareness programs.

7.0 Beyond A One - Call System

Alberta 1st Call does much more than receive phone calls from excavators and transmit messages to owners of buried facilities. The scope of its activities is constantly expanding.

7.1 Statistics

As a non-partisan organization with members from every sector of the buried facility fraternity, Alberta 1st Call is well placed to promote the use of a universal damage report form. It collects massages, interprets and publishes damage statistics.

With the reporting of damages in a consistent format, statistical analyses can develop a profile of a damage incident, identify appropriate audiences for advertising and public awareness programs, identify the "bad apples" in the digging community and provide a comparative measure, from year to year, of the effectiveness of advertising and public awareness programs, the susceptibility to damage of the various types of buried facilities and even the susceptibility to damage of individual facility owners.

7.2 Coordination

As the communication link between the digging community and the owners of buried facilities, Alberta 1st Call can be the voice of both and foster cooperation between them.

Alberta 1st Call representatives sit on a variety of committees and provide liaison among them.

There are many organizations whose interests overlap those of Alberta 1st Call and with whom Alberta 1st Call can work. There are mutual benefits and synergistic effects to this type of coordination and cooperative effort.

7.3 Information

Alberta 1st Call is a source of information for the digging community, for the owners and operators of buried facilities and for related groups and organizations. In addition to statistical information related to damages and locate requests, Alberta 1st Call keeps its members abreast of one-call system and damage prevention activities in the USA.

Representatives participate in member and contractor safety and training programs and provide speakers for seminars and conventions.

7.4 Standardization

Within the protocols of excavation near buried facilities both the owners of the facilities and the excavators have expectations of each other. Alberta 1st Call is in the position of being able to help make these two sets of expectations compatible.

Alberta 1st Call has been instrumental in the standardization of marking colour codes, buffer or control zones and guidelines for safe excavations.

8.0 Damage Prevention

Prevention of damage to buried facilities must be a priority for any organization that owns or operates buried facilities and for any person or organization that is involved in disturbing the ground. A one-call system is only one weapon in the damage prevention arsenal.

Membership in a one-call system and use of the one-call system must, like any safety program, be a corporate decision, not an operating decision.

9.0 Responsibilities

Both the digging community and the owners and operators of buried facilities have a responsibility to protect workers and the integrity of society's essential services.

The digging community must:

- recognize the inherent dangers in disturbing the ground;
- request that the owners of buried facilities identify and mark the locations of these facilities before any ground disturbance takes place;
- hand expose buried facilities in conflict with a ground disturbance before using mechanical equipment near them; and,
- dig prudently to minimize the effects of ground disturbances on buried facilities.

The owners and operators of buried facilities must:

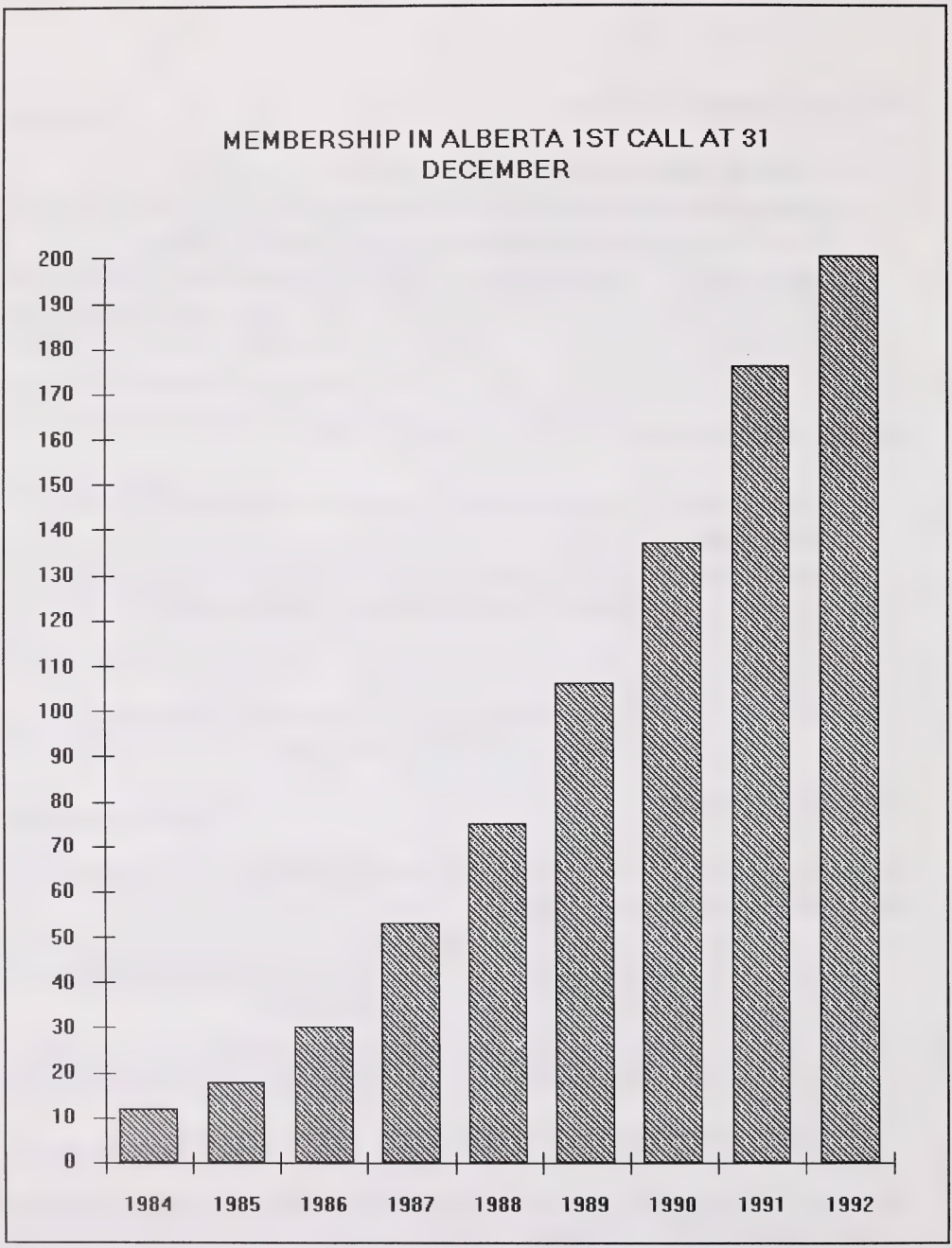
- install facilities in accordance with accepted practices and governing regulations;
- respond in a timely manner to requests for locates;
- develop an awareness of the digging community's constraints and concerns; and,
- generate a respect for the integrity of their facilities on the part of the digging community.

10.0 Call To Action

Members of the Alberta Water and Wastewater Operators Association can help reduce damage to buried facilities.

- promote the establishment of one-call systems where none exist
- promote membership in existing one-call systems
- promote the use of one-call systems
- participate in local utility location, coordination and damage prevention groups
- make "Call Before You Dig" part of your safety program.

If you are concerned about the possible consequences of a hit, you and one-call systems have mutual concerns.


MEMBERSHIP IN ALBERTA 1ST CALL AT 31 DECEMBER
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1984
1985
1986
1987
1988
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1990
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1992

Figure 1

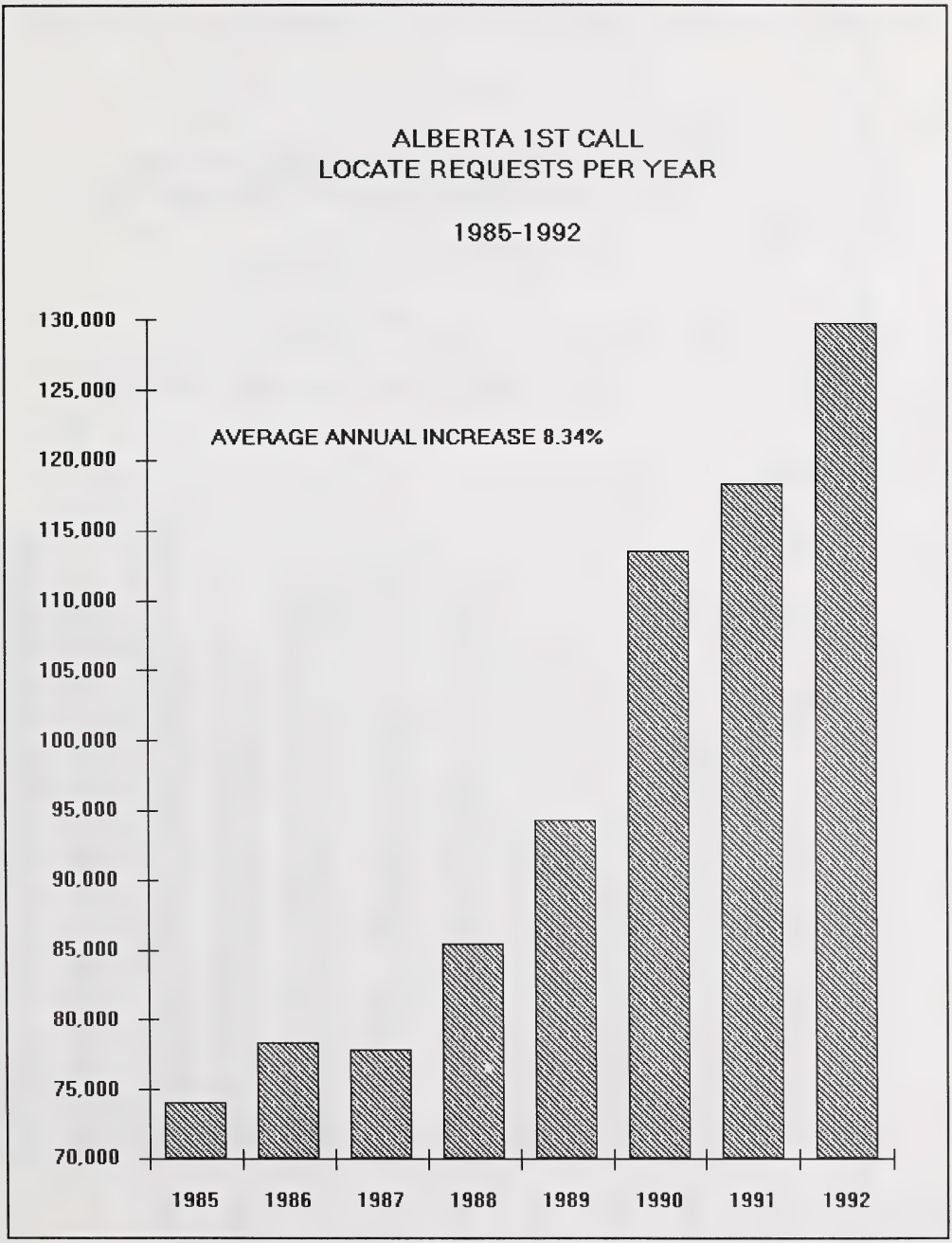

ALBERTA 1ST CALL
LOCATE REQUESTS PER YEAR
1985-1992
AVERAGE ANNUAL INCREASE 8.34%
130,000
125,000
120,000
115,000
110,000
105,000
100,000
95,000
90,000
85,000
80,000
75,000
70,000
1985
1986
1987
1988
1989
1990
1991
1992

Figure 2

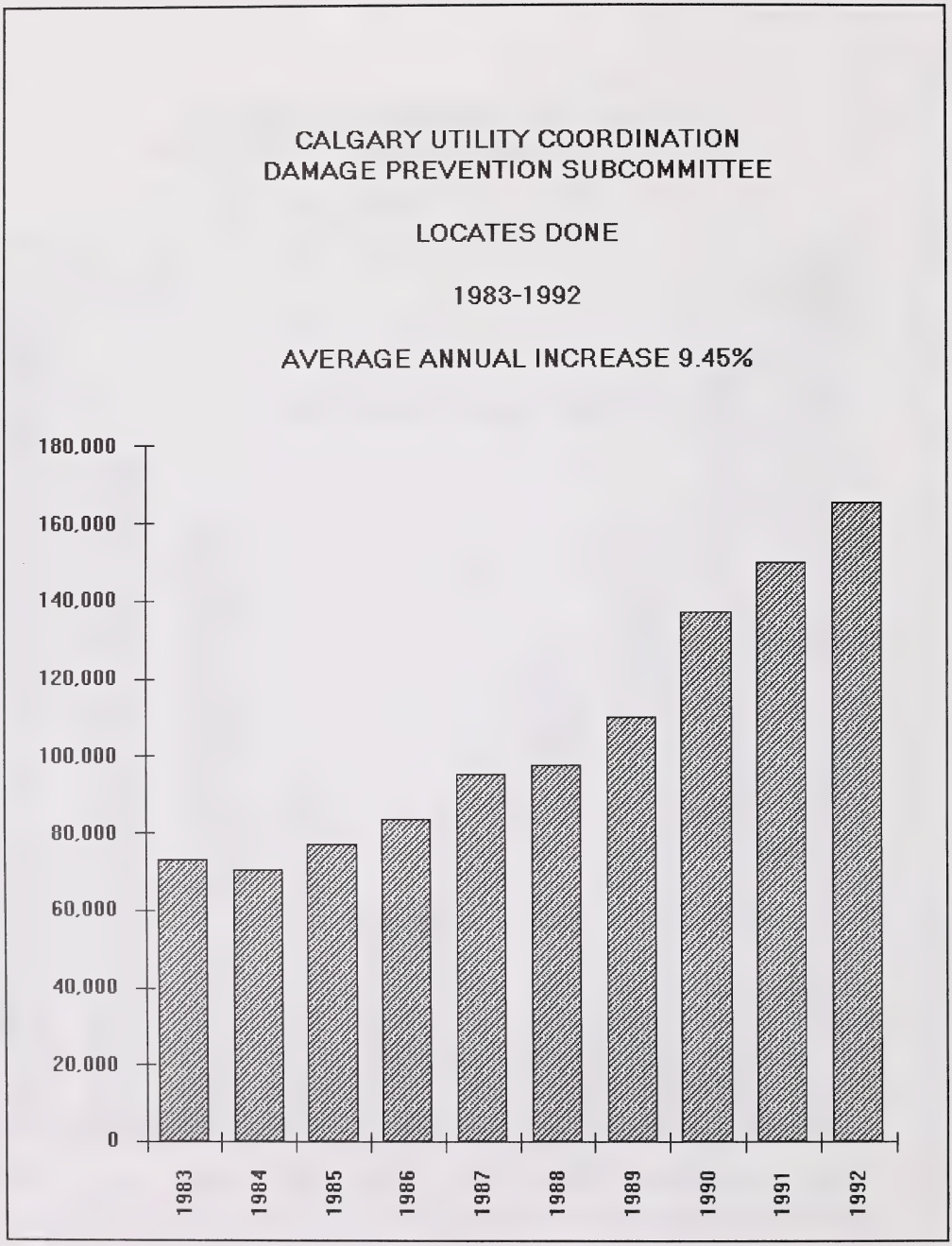

CALGARY UTILITY COORDINATION
DAMAGE PREVENTION SUBCOMMITTEE
LOCATES DONE
1983-1992
AVERAGE ANNUAL INCREASE 9.45%
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

Figure 3

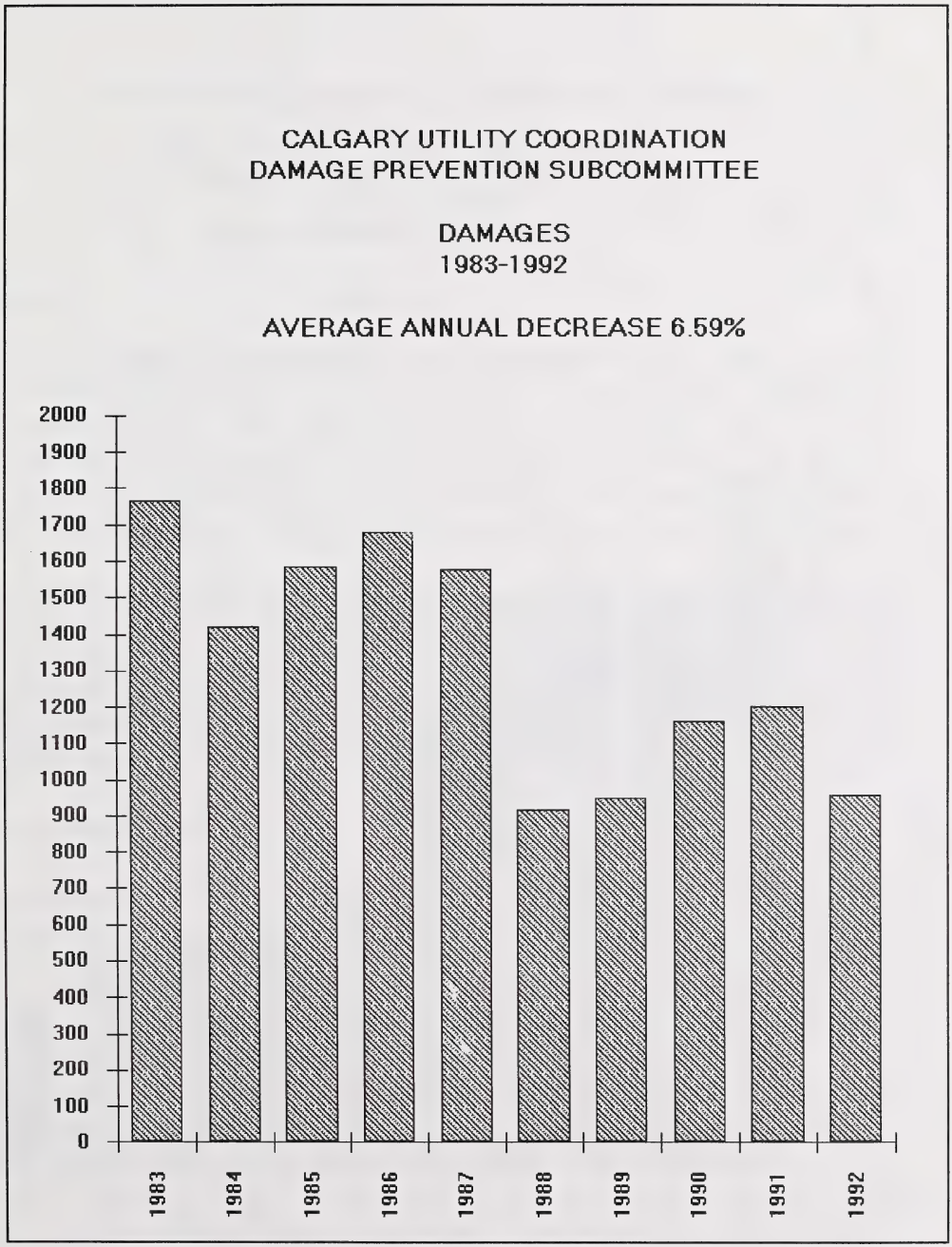

CALGARY UTILITY COORDINATION
DAMAGE PREVENTION SUBCOMMITTEE
DAMAGES
1983-1992
AVERAGE ANNUAL DECREASE 6.59%
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

Figure 4

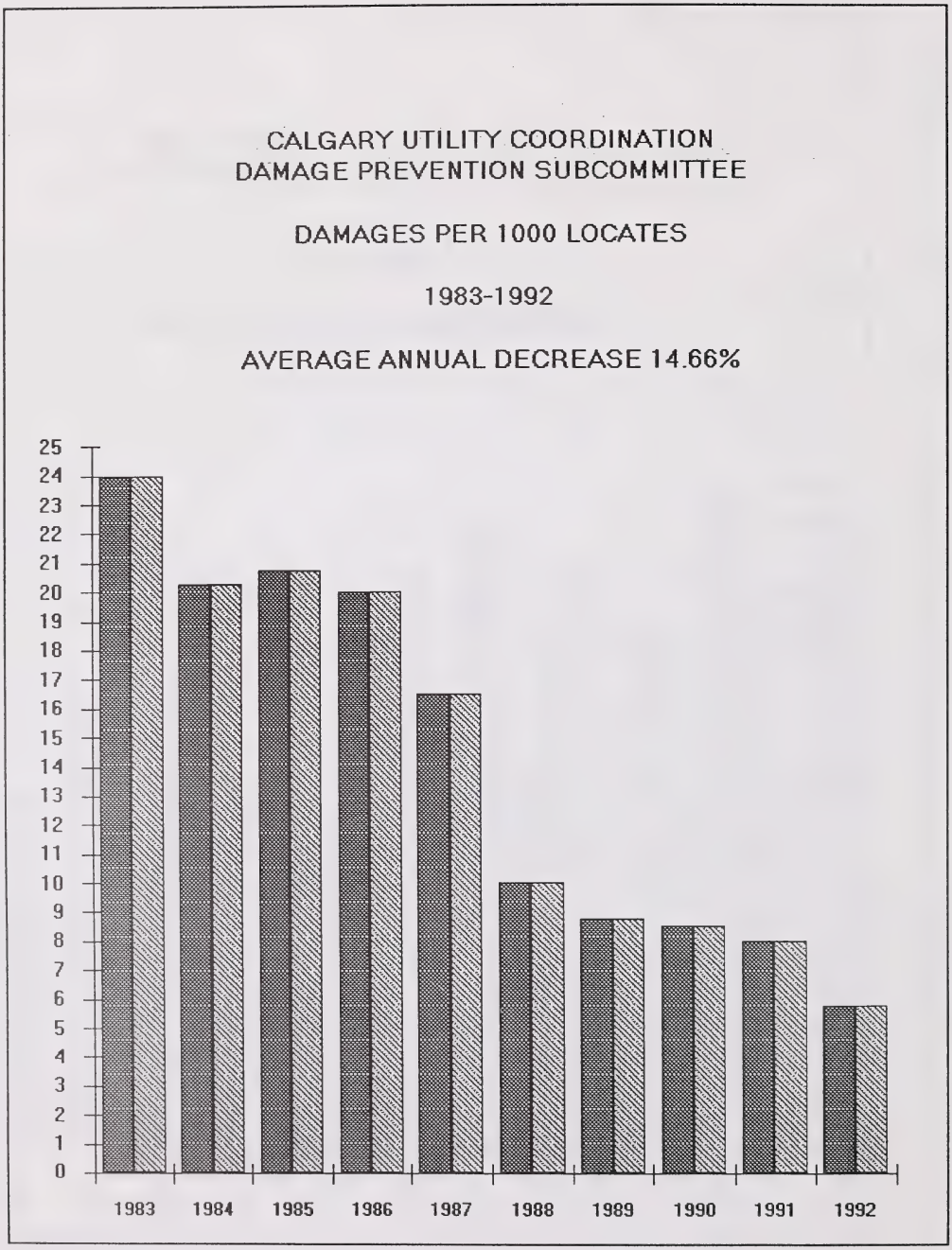

CALGARY UTILITY COORDINATION
DAMAGE PREVENTION SUBCOMMITTEE
DAMAGES PER 1000 LOCATES
1983-1992
AVERAGE ANNUAL DECREASE 14.66%
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

Figure 5

Freeze/Thaw Dewatering of Alum Based Sludge

K.P. Voss, P. Eng.
City of Calgary
Waterworks Division

Background

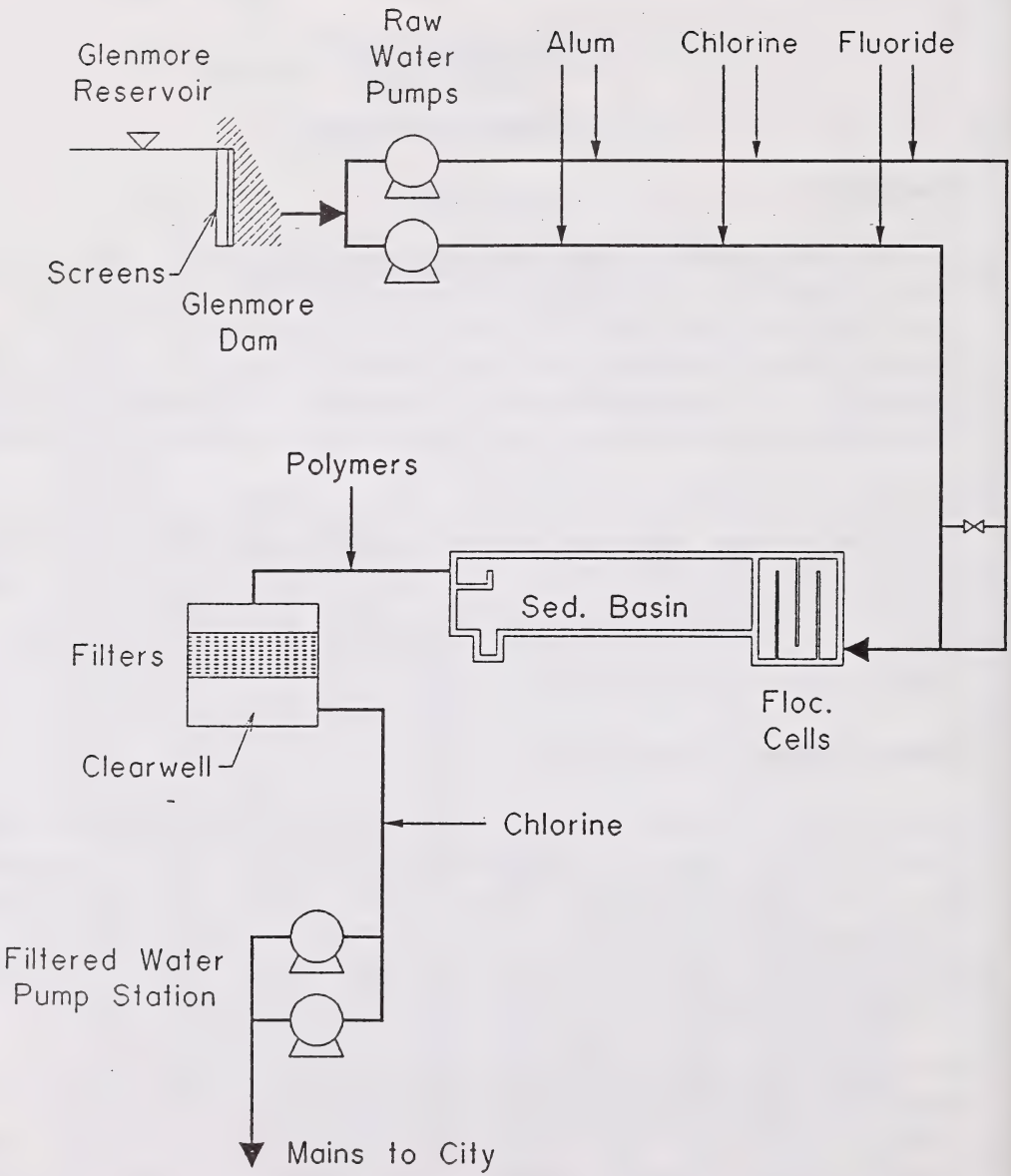
The City of Calgary owns and operates two conventional surface water treatment plants. These plants, the Glenmore Water Treatment Plant and the Bearspaw Water Treatment Plant, both utilize similar treatment processes (Figures 1 & 2) including primary disinfection with chlorine, chemical coagulation with aluminum sulphate (alum), cross flow sedimentation, fluoridation with hydrofluosilicic acid, filtration with either dual media or sand filters and post disinfection with chlorine.

At both plants, the sedimentation basins accumulate an alum based sludge which is removed annually. Historically, both plants handled the disposal of this sludge in different manners. The sludge form the Glenmore Plant was discharged directly to the Elbow River downstream of the Glenmore Dam. The sludge at the Bearspaw Plant was pumped from the sedimentation basin to two sludge lagoons located west of the main plant site.

Glenmore Water Treatment Plant

Annual cleaning of the sedimentation basins at the Glenmore Water Treatment Plant has normally occurred in the early fall of each year. Cleaning of the basins was accomplished by discharging the accumulation of alum sludge to the Elbow River downstream of the Glenmore Dam. In conjunction with this discharge, additional water was released from the Glenmore Reservoir to the Elbow River to provided adequate dilution of the discharged sediments.

This method of disposal of alum based sludge has historically been a common practice in the water treatment industry. Alberta Environment, in the City's Licence to Operate the Glenmore plant, approved this method of disposal. Recent research, both by Alberta Environment (Alberta Environmental Centre, 1986) and the American Water Works Association - Research Foundation (George et al., 1991), confirms that the discharge of alum based sludge to receiving streams is nontoxic to aquatic life. However, in recent years this procedure has raised some



Glenmore Water Treatment Plant
Figure 1

Bearspaw Water Treatment Plant
Figure 2

concerns with both the general public and regulatory agencies.

As a result of these concerns and in an effort to be proactive on an environmentally sensitive issue, the City Engineer for the City of Calgary directed the Waterworks Division to discontinue permanently the discharge of sedimentation basin sludge to the Elbow River. Subsequently, the City notified Alberta Environment on February 13, 1989 that it would cease disposing of this sludge to the Elbow River.

In order to comply with this new directive for 1989, and with limited disposal options available, the decision was made to transport the sedimentation basin sludge from the Glenmore plant to the existing sludge lagoons at the Bearspaw plant.

Bearspaw Sludge Lagoons

The Bearspaw Water Treatment Plant was constructed in two phases. Included in the construction of Stage 2 were two sludge lagoons. These two lagoons, each capable of holding 12,000 cu.m., were designed to be used in the annual removal of sludge from the Stage 2 pretreatment facilities. Since the commissioning of Stage 2 in 1984, this cleaning of the pretreatment facilities has been done in late September or October of each year. Due to their size, and the volume of sludge produced between 1984 and 1988, it had not been necessary to empty the lagoons of their accumulation of thickened sludge.

These lagoons had been designed to utilize freeze/thaw drying of the alum based sludge to allow for the ultimate disposal of the thickened sludge to a sanitary landfill. However, in practice these lagoons were not operated in a manner which would allow effective freeze/thaw drying action. This was a result of a concern about the ability of the lagoons, as constructed, to withstand complete freezing of the material in the lagoon and the sub-base. Figure 3 shows a cross section of the base. It was felt at the time that if water had penetrated below the asphalt layer then heaving and possible destruction of the lagoon could possibly occur.

Therefore, in accordance with the operations manual provided for Stage 2, the lagoons were topped up with water at the end of the annual desludging operation. This resulted in a sludge/water depth of approximately 1.5 metres. Once surface freezing of the lagoon occurred in the early part of the winter, the benefits of the

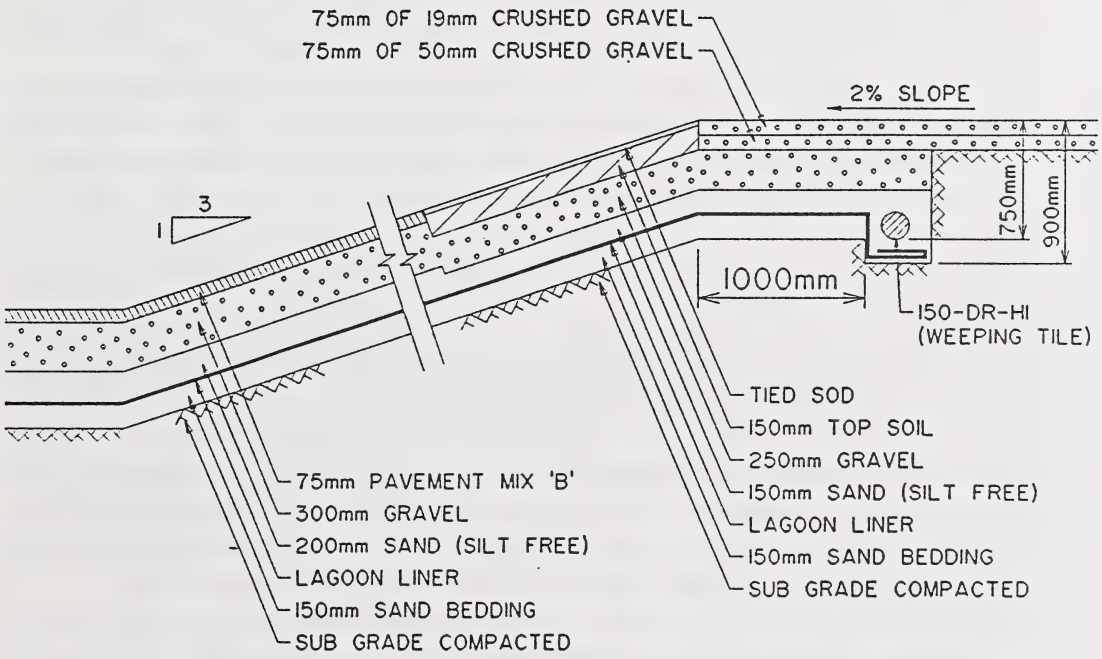

75mm OF 19mm CRUSHED GRAVEL
75mm OF 50mm CRUSHED GRAVEL
2% SLOPE
3
1
750mm
900mm
1000mm
150-DR-HI
(WEEPING TILE)
TIED SOD
150mm TOP SOIL
250mm GRAVEL
150mm SAND (SILT FREE)
LAGOON LINER
150mm SAND BEDDING
SUB GRADE COMPACTED
75mm PAVEMENT MIX 'B'
300mm GRAVEL
200mm SAND (SILT FREE)
LAGOON LINER
150mm SAND BEDDING
SUB GRADE COMPACTED

Figure 3

freeze/thaw action on the sludge were reduced. As a result, a thickened sludge of only ten percent solids was being produced from an initial sludge of one to two percent solids; considerably poorer performance than the predicted result of seventeen to twenty percent solids (Schaefer and Clark, 1989)

In the fall of 1988 an attempt was made to remove this sludge from the Bearspaw lagoons using a vacuum truck. Though the truck was able to load this material, a number of problems were encountered. The first problem related to the variable consistency of the sludge in the lagoon. Over the fifty centimetre depth of thickened sludge in the lagoon, the material varied from a dry, hard, broken crust at the surface to a liquid, paste like consistency at the bottom. Physical mixing of this material did allow for its loading using the truck's vacuum system but it did require significant manual effort to accomplish this.

The second problem was the disposal of this material. Due to its low solids content, approximately ten percent, land filling would only be possible at the City's Forest Lawn landfill, a relatively long haul from the Bearspaw Water Treatment Plant. The other possible disposal site would have been the Sheppard sludge lagoons operated by the City's Sewer Division.

Neither disposal site was considered desirable. The landfill site would be expensive to use due to the cost of hauling material and the dumping fees (hauling cost - $15/t., dumping cost - $15/t., 1988 costs). The Sheppard lagoons have approximately the same hauling cost initially plus the additional cost of ultimate disposal from these lagoons. The Sheppard lagoons are used by the City's Sewer Division to thicken sludge from the City's two secondary waste water treatment plants prior to final disposal as a soil conditioner through subsurface injection. The sludge being disposed of from the water treatment plants is primarily a mixture of inorganic solids and aluminum hydroxide. This sludge would not benefit-the existing land application operation as the two major components are not useful soil conditioners (Elliot et al., 1990).

As a result of this trial in the fall of 1988, it was decided to modify the operation of the Bearspaw sludge lagoons for the 1988/89 winter season. To begin, during the annual desludging operation at Bearspaw, sludge was only added to the west lagoon. This would provide an opportunity to measure the effectiveness of the changed procedures on the existing sludge in the east lagoon as well as the sludge placed in the west lagoon during the fall of 1988. At the end of the

desludging operation at Bearspaw, the west lagoon was decanted prior to freeze up to minimize the amount of standing water over the sludge blanket.

Normal procedure was to top up the lagoon to the minimum decant level which resulted in a total sludge water depth of 1.5 metres. This was not done for the 1988/89 winter, rather the east lagoon was left in its surface dry state and the west lagoon was allowed to continue to decant until freeze up occurred. This resulted in a sludge blanket of between 0.5 and 1.0 m. in the two lagoons.

Less ice was formed over the sludge blanket and a more active freeze/thaw cycle occurred over the course of the winter. Visual inspections of the lagoon indicated a marked improvement in the performance of the lagoon. Ice lenses were observed and noticeable drying of the sludge appeared to be occurring as predicted in recent articles on the subject of natural freeze/thaw drying of sludge Cornwell and Koppers, 1990).

Preliminary results, based on testing done in May, 1989, showed the sludge in the east lagoon had improved from ten percent solids to thirty percent solids, while the west lagoon was tested at sixteen percent solids. A more comprehensive sampling of the east lagoon was done in June, 1989 and the results showed the sludge at an average of forty-two percent solids. Given these results, it was decided to remove the accumulation of thickened sludge from the east lagoon by trucking this material to a sanitary landfill site.

Given the moisture content and nature of this material, it was accepted at the nearby Spyhill landfill as clean fill. Material handling required a front end loader on rubber tires and tandem dump trucks. Over a four day period in June, 1989 approximately eight hundred and seventy-five tonnes of material were removed from the east lagoon and transported to the Spyhill landfill for disposal. Equipment and labour costs for this operation were approximately $8,000.00, not including supervisory costs. The average cost of cleaning this lagoon and disposing of the sludge was approximately $ 9.15/tonne.

Given the earlier concerns regarding possible damage to the lagoons from full depth freezing, the lagoons were inspected upon completion of the cleaning operation. The inspection of the east lagoon determined there was no visible damage to the asphalt base or the inlet and outlet structures, either from the freeze/thaw action or from the cleaning operation.

As a result of this experience, it was proposed to continue using the sludge lagoons at Bearspaw with this modified operating procedure. During the annual desludging operation at Bearspaw in the fall, the recently cleaned lagoon was used as the current year's active lagoon and the other lagoon was allowed to remain in its surface dry state. Both cells are allowed to go through freeze/thaw cycles during the winter without any additional water being added to the lagoons. The opposite cell would then be cleaned during the following summer and then utilized during the desludging operation the next fall. In this manner one cell would be cleaned each year and the other cell would be exposed to two years of freeze/thaw drying action.

Recent Developments

Since 1989, a number of improvements have been made to these new procedures for operating the Bearspaw sludge lagoons and for transferring the sedimentation basin sludge from the Glenmore to Bearspaw Plant. At Glenmore, an improved method of decanting the sedimentation basins has been added to allow for a more controlled release of water through the drain gates without disturbing the sludge blanket. As well, a permanent sludge transfer system has been constructed which minimizes the use of hoses and provides a safer method of loading the tanker trucks. Changes to how wash water is added to the basins to minimize dilution of the sludge prior to loading on the trucks have also been made. And, in addition, a better method of discharging the sludge from the tanker trucks to the lagoons has been built to prevent damage to the sides of the lagoons at Bearspaw.

With respect to the operation of the lagoons, the importance of minimizing the standing water on top of the lagoon at the end of the desludging operation has been noted. If the active cell can be decanted to as near a surface dry state as possible, the degree of drying over the following winter is greatly improved. As well, the severity of the winter weather has a noticeable effect on the performance of the lagoons.

The winter of l991/92 was relatively mild in Calgary and the west lagoon which was in the second year of the two year cycle did not freeze completely at any time during the winter. This resulted in a poorer than hoped for performance in the lagoon, the sludge removed during the summer of 1992 only being at a solids content of thirty one percent. However, even with this result, the material could still be loaded with conventional rubber tired loaders and hauled by dump trucks to

the nearby sanitary landfill.

Conclusions

During the past four years, the City of Calgary Waterworks Division have been able to eliminate the discharge of sludge to the Elbow River from the sedimentation basin at the Glenmore Water Treatment Plant. This has been accomplished by transporting the sludge from the Glenmore plant to the two existing sludge lagoons at the Bearspaw Water Treatment Plant. As well, the performance of these two sludge lagoons in dewatering the alum based sludge through the use of natural freeze/thaw has been enhanced through changes in operating procedures. These changes have resulted in the sludge being thickened from approximately one percent solids to forty percent solids over a two year period. This has allowed for the ultimate disposal of this treatment plant residual to a nearby sanitary landfill.

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Take a Shot at Risk Management

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Loss Control Consultants Limited
Edmonton

For people who have negative thoughts, this title could mean to shoot down the concept. For most of us, it means that although we don't know How, When, Where or Why to begin, at least we try!

Risk Management means different things to people with diverse backgrounds, so here are some meanings from the dictionary.

What is Risk Management?

Risk is a chance of encountering harm or loss. Management is defined as the skilful use of means.

Risk Management is a complex issue which is best divided into categories, to be handled by different departments or individuals. Most of you would have no responsibility for the risk of managing your municipality's finances. But you do have responsibility for supplying services of sufficient capacity and quality to meet the demand on your systems.

What are hazards?

Hazard is a chance of loss or accident.

This talk is an overview of some beginning elements of a Municipal Risk Management Program.

Fig. 1 Wastewater

Let's Start A Municipal Risk Management Program

I can hear some of your response(s) now! ... What, AGAIN?, ... We don't have time! ... We don't have the people!! ... We don't have the money!!! ... #@%$*&^(+=_<>?!!!! Who is this guy? How can he tell us what to do? What does he know about water and waste water treatment?

Well, in comparison to most of you, I don't know all that much about water and waste water treatment, although I have been in most of the water and waste water treatment facilities in urban Alberta. I have also installed and cleaned wells and septic systems. However, that is not the point! The point is that I do know something about loss prevention or loss control and/or risk management. I know that some things work and others don't. I also know that if you don't try something, it **NEVER** will work!

As Thomas Fuller once said: "Get the facts or the facts will get you. And when you get 'em, get 'em right, or they will get you wrong".

Fig. 2 - Identification

Elements of Risk Management include:

Identification:

a continuous process to identify responsibilities related to possible accidental loss exposures

Some accidental loss exposures might be:

1. Undersupply of water
   a) insufficient volume and/or pressure for domestic, commercial, industrial or fire use
   b) inadequate quality because of purity, taste or odour
2. Oversupply of sewage
   a) obstruction resulting in sewer backup in customers property

3. Undersupply of sewage disposal
   a) inadequate piping resulting in the above
   b) inadequate storage and/or treatment facilities

Evaluation:

an analysis of past losses and estimated future incidents together with an analysis of the effectiveness of preventive procedures already in place

Examples are:

1. Line breaks/blocks
   a) flooding
   b) sewer backup

Control:

a decrease in or exclusion of risk through effective strategies.

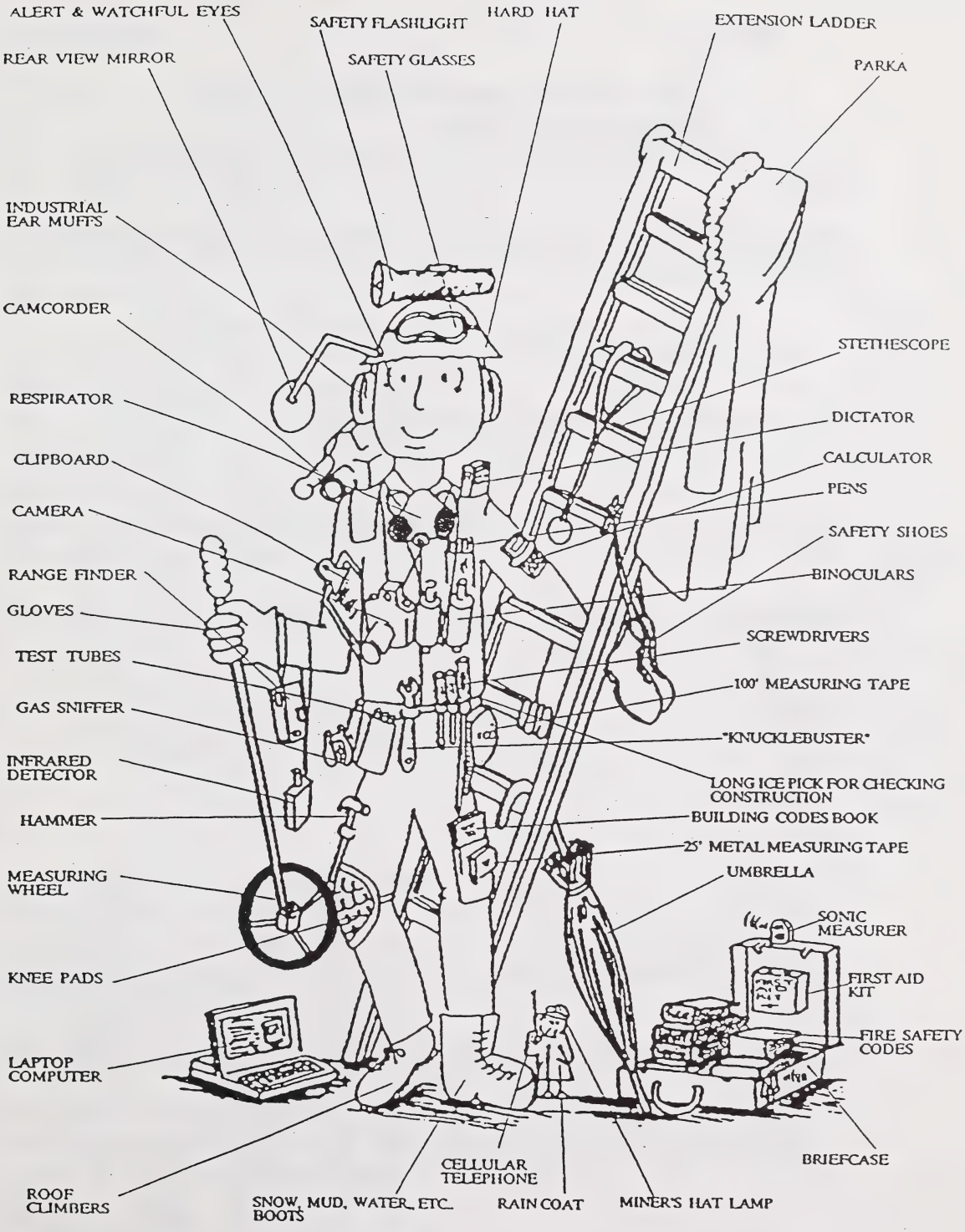

Fig. 3 - Inspector

What to do:

1. inspect and make recommendations
2. complete recommendations

Funding:

Will Rogers said: " One-third of the people in the United States promote, while the other two-thirds provide".

provision of adequate financial resources including insurance

This is normally a function of administration.

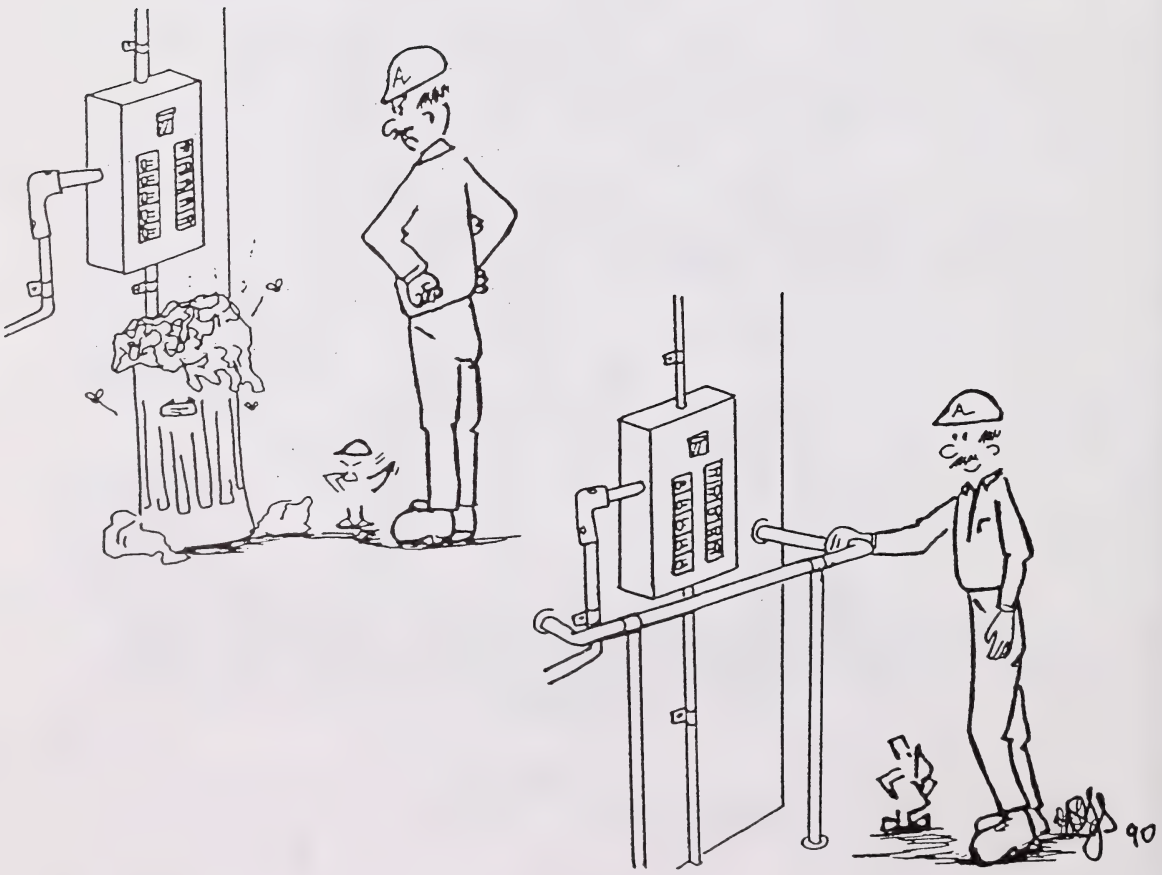

Fig. 4 - Foreman

use of skills of staff and outsiders

This may be main administration or may be delegated to departmental administration.

You are going to hear about Municipal Risk Management, more and more, from more and more sources. So, why don't you beat the rush, or deadlines imposed by someone else and find out now, "What its all about."

For those of you in urban municipalities, your municipal voice, the AUMA, has begun the process by providing a comprehensive General Insurance Program, which includes insurance appraisal and loss prevention services, provided by Loss Control Consultants Limited. While these services are an important part of "Risk Management," they only touch the "tip of the iceberg." It is interesting that the AUMA is the only Municipal Association in Canada to offer a program with such a scope. Other jurisdictions have programs that are similar in some respects, but do not compete in the long run.

What else should be included? The list could go on forever, but some vital areas are:

a) Preventive maintenance program
b) Inspections to identify and remove hazards
c) Staff training to extend their capabilities (cross training)
d) Etc.

As always, the startup costs will not make the first year look as if risk management is a cost-saving program. Sometimes, even the second year does not have a good balance sheet, but after that, the effect kicks into second gear, then into high. Before long, you will have the black bottom line and will be able to extend your program even further.

The language I am using may be trite, but we hope to GET YOUR ATTENTION!

FACT: If you complete loss prevention recommendations, losses are reduced, if not entirely prevented. It is also a FACT that when you do not complete loss prevention recommendations, losses do occur.

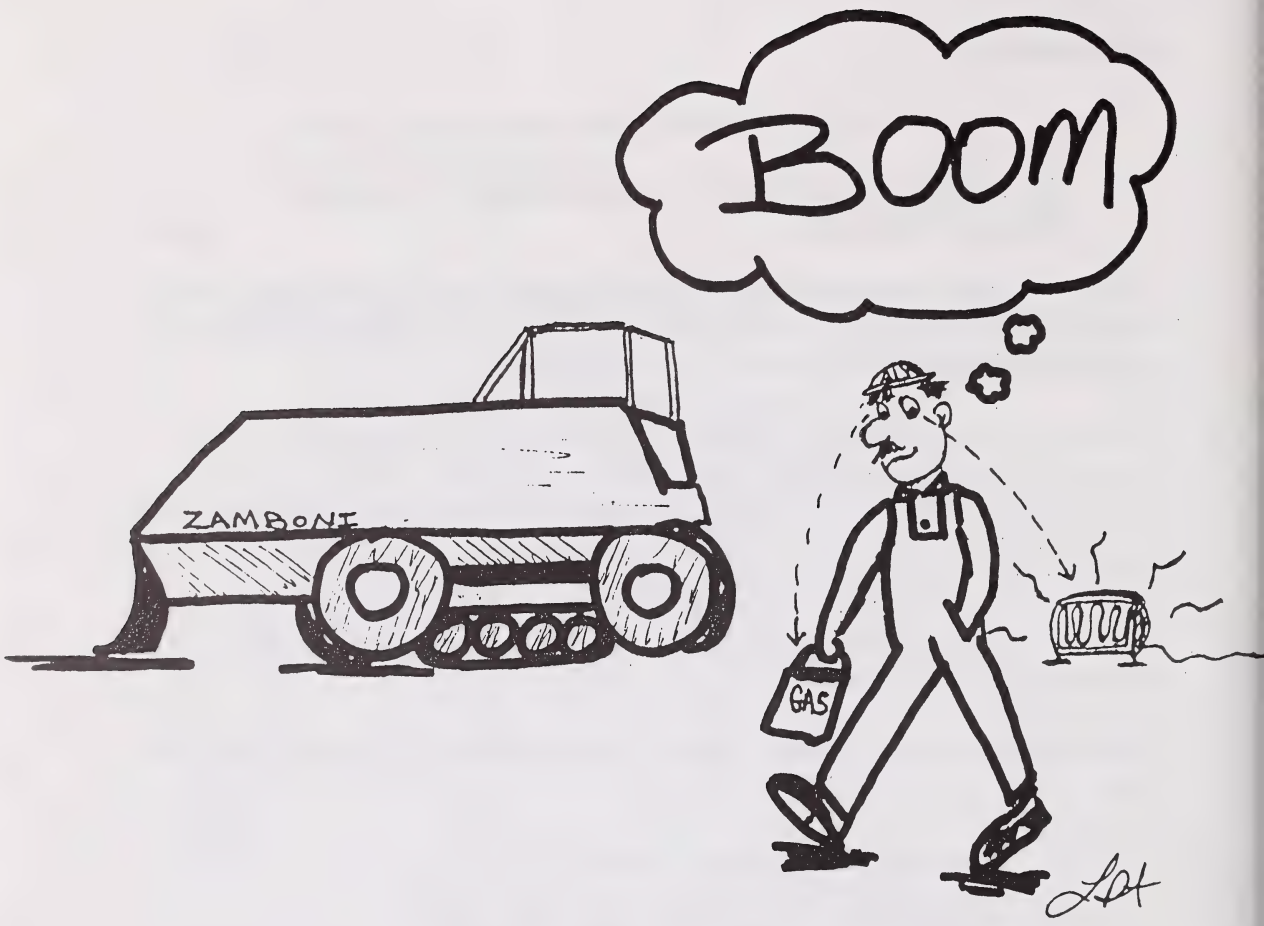

Fig. 5 - Zamboni

Something similar to this example happened recently. Fortunately, the fire department did a really good job and saved more than the foundation.

Suppose there is a gasoline fuelled lift truck used in a large municipal facility. Because "it is cold," "it is not convenient" or for some other reason, a worker refuels the vehicle indoors. Always avoid this hazard. Suppose also, there is a natural gas fired appliance set on the floor in the same area. Vapours can easily spill from the refuelling operation, travel across the floor and be ignited by the pilot light of the appliance. The result, if not a total loss, is substantial. This carelessness costs everyone money!

In this case, we had recommended that the appliance be raised or otherwise moved. We did not know about the refuelling inside although we thought it likely.

In another incident, which was reported to have happened a number of years ago, waste water workers were making a routine operations check on a small lift station which looked like a small outhouse. When they opened the door, the building exploded. Methane gas had accumulated; there was a small open coil electric heater; when the door was opened, there was sufficient oxygen to fuel the blast.

We had previously recommended that the open coil heater be replaced with a suitable heater.

Some ramifications of losses are:

a) The facility is partly or totally out of use until repaired
b) Municipal employees must develop a "proof of loss," which takes them from their routine work
c) If a written recommendation to correct the situation existed before the loss, failure to have completed the recommendation may be gross negligence, which may be a violation of the insurance policy

Remember, you first need to identify your risks, then you evaluate and last but definitely not least, you control!

We can assist you in the implementation of a Risk Management Program, designed for YOUR department or your municipality.

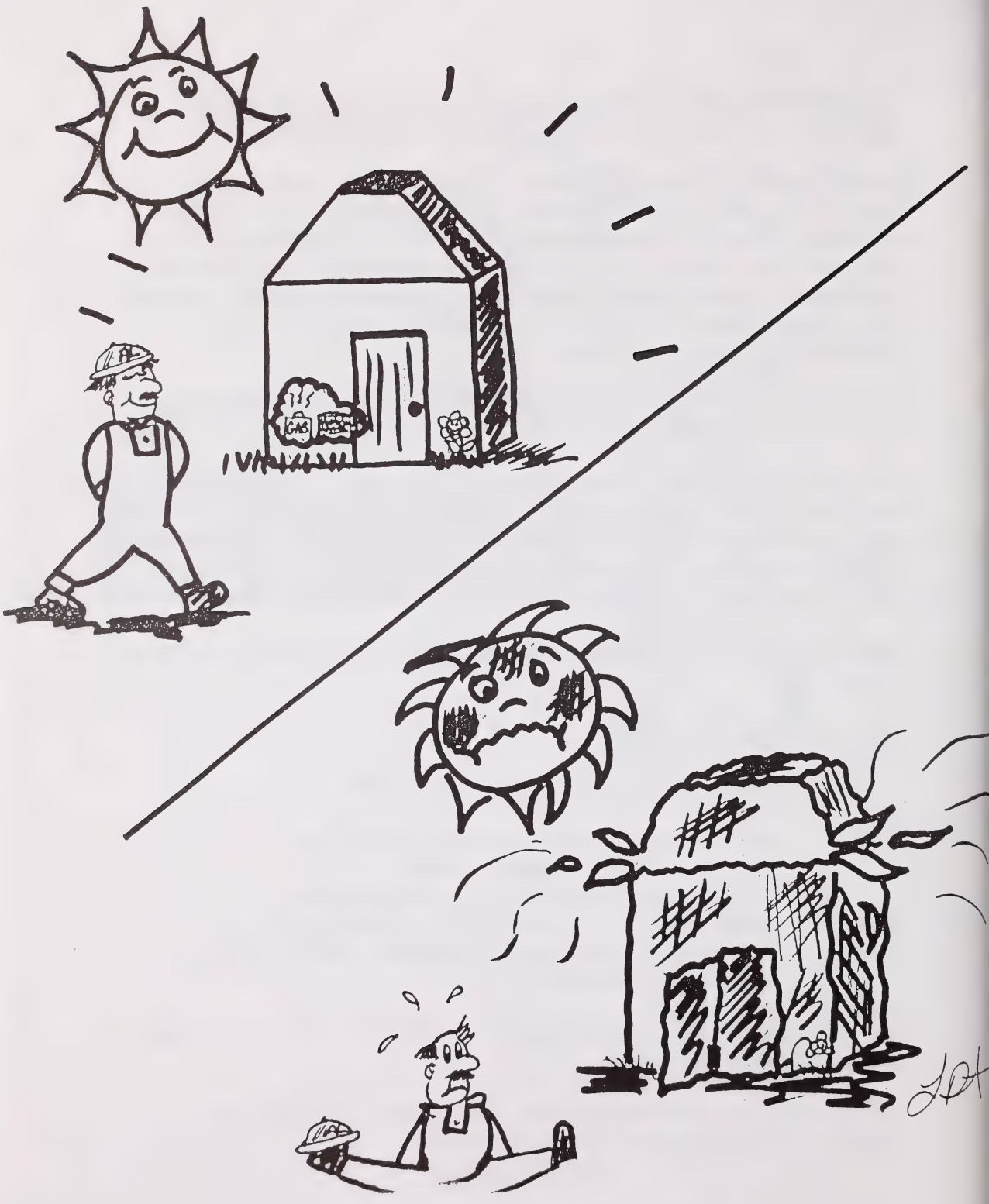

Fig. 6 Lift Station

Are You Ready For The 21st Century?

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It's a sobering thought, in less than 7 years the 21st Century will begin, wether or not we're ready for it. For many of us in the wastewater collection system this means a different approach to the way we handle our responsibilities. No longer are we needed just to relieve blockages, as it was in the past. Today's collection system management includes a wide array of different tasks, and demands a higher degree of professionalism.

To be sure, there are a lot of agencies that are working to increase the efficiency and effectiveness of their systems. This process can include many variables, and to be successful should be handled in steps to assurer overall success.

One of the basic questions that an agency can ask itself is what are our responsibilities? Our primary task is to take wastewater from a point source to a point of treatment or discharge, keeping the used water in the system, and fresh water out of it. However, there is far more to it than that.

One of the first things to tackle in upgrading the professional level of an agency is to be sure everyone understands what they are supposed to be doing and why. Does your agency have a published mission statement that includes most of these points? This mission statement is generally a short statement that outlines the scope of the agency's goals. It should be understood by everyone so that the agency can work as a team, and not assorted departments. Everyone on the team should understand their particular responsibilities to the agency, as they relate to the achievement of the mission statement. Everyone from the director to the entry level position should have a written job description that allows each employee to dovetail their work with others to allow the system to run smoothly, and advances the mission statement of the agency.

One of our primary concerns in the collection system is to provide an environment where the flow is not interrupted or blocked. Problems in the collection system that could cause flow interruptions come from many sources such as; root intrusion, waste oil and grease deposits, separated solids and debris, hydraulic bottlenecks, poor installation and damaged pipes, and many other considerations.

All of these problems can lead to failure of the system.

Coupled with the physical realities of the system itself are nonphysical issues such as the political realities of budget constraints, training and education of agency personnel, design problems, and safety concerns. All of these issues have a bearing on the collection system. All things considered this is not an easy problem to solve. Probably the best way to tackle most of the system problems is to establish a regular preventive maintenance (P/M) program.

The importance of a P/M program is not in what it can do for you know, but what it will do for you 5 years from now. It will save money. A P/M program is set up so that the agency can catch a problem before it develops into a catastrophic failure and damage to property occurs. The routine or systematic cleaning of the system is the first step.

By being out in the field, personnel can see problems that exist and can remedy, or make notes on various things for the planned repair that needs to be done. This is a complex job, depending on the size and age of the system in a particular area, and requires an advanced level of expertise. The only way this level of expertise can be reached is though on going training and collection system certification.

The importance of training of collection system personnel cannot be understated. Lack of proper training can actually make problems worse for the agency by not having the ability to recognize potential problems before they become emergencies, equipment failure due to lack of maintenance, constituent ill wishes due to poor handling by employees, and funding problems due to the perceived lack of professionally in the agency by the political forces that grant these funds.

Probably the most understated detail in collection system operation is record keeping. The P/M programs success depends on accurate, detailed records of the system. Records will determine where efforts by the field operators will be directed. Whether it is a routine cleaning of specific lines, repair or replacement of old or structurally damaged pipes, or the addition of new lines to the system, records will be crucial. In many instances proper records can eliminate unwarranted claims of damage by system users by eliminating the opportunity for them to apply negligence standards in the courts. Your P/M program can solve this tort law by allowing work in the system that defeats the four major tenants of the negligence standards;

1. Inadequate maintenance,
2. Unreasonable time to unplug stoppages or fix known problems,
3. Actual notice, failure to address problems identified by field staff or users, and
4. Constructive notice, failure to actively look for problems in the system.

In collection system maintenance operations there are several kinds of equipment that are used. Each piece of equipment has specific uses and fills a niche in a P/M program. This equipment falls into two categories, mechanical cleaners and hydraulic cleaners. The hydraulic cleaners are the flushing machines that used pressurized water to move static materials that accumulate in the pipe. These types of cleaners are designed primarily for P/M operations and routine cleaning. Through proper use and record keeping, these machines will tell the collection system manager where the mechanical cleaners should go for problems such as hardened grease build up, root infiltration, and heavy sediment deposits in larger pipes.

Mechanical cleaners will include roding machines, who's primary task is to cut through roots and other organic and hard deposit debris that the hydraulic have difficulty with. In large lines, the hydraulic cleaners become increasingly less effective as the diameter of the pipe grows. The other type of mechanical cleaner are bucket machines. These machines are designed to remove settled debris from these large pipes more effectively than other means.

It is up to the agency to determine what their needs are in respect to how large their system is in kilometres (miles), the diameters of the pipes involved, and the age of the system. Some agencies with newer systems need only hydraulic cleaners until the system becomes older, and materials settle out in the large interceptors. Other systems need both types of cleaners due to age, neglect, and objectives that have been determined.

The 21st century will bring about more advanced safety equipment than is currently available. This can be dramatically pointed out by the advances over the last 10 years or so. I for one figure the rate of advancement that has been established over this period, and apply that to the future, it does not require a lot of imagination to foresee what lies in the future.

21st century technology in computer applications will be far reaching. The state of the art in small portable computer systems now is remarkable. What used to take up an entire floor at Stanford University in computer capacity, now can be fit into a

standard briefcase. Pen based systems, where by writing with a pen onto a computer screen will translate to a computer generated type is here already, and will expand to field operations. Allowing the operator not to have to use a standard key board. This will be one of the greatest advances for field operations since the advent of pencil and paper, and will make computerized records easy and usable.

The 21st century promises great things for our industry, safety advances in equipment and operations, advances in our ability to respond to and predict problems in the field, and significant advances in the professional abilities of operators. Those not yet into 20th century technology at this point only have 7 years left until the 21st century arrives. For those who insist that their operations stay at the cutting edge of technology, the next century will be an exciting place indeed.

Cost Effective, Hassle Free, Sludge Management

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Lambourne Environmental

Introduction

The major goal of municipal wastewater treatment is to produce a liquid effluent which is suitable for discharge to the environment. To achieve this goal, a variety of physical, chemical and biological processes can be employed. While these processes produce a treated wastewater they also result in the production of a residue commonly referred to as sludge.

Principally organic in nature, municipal sludge also contain varying quantities of metals, nutrients, salts, grit, synthetic organics and pathogenic organisms. The exact composition of sludge is a function of the wastewater being treated and can vary significantly from municipality to municipality depending on the quantity and quality of industrial, commercial and institutional inputs. In general, as treatment efficiency increases the volume of sludge increases.

Sludge must be disposed of in an environmentally acceptable manner if wastewater treatment, as a whole, is to be considered effective. The purpose of this paper is to explain how sludge can be agriculturally utilized using the most cost effective and environmentally sound methods currently available in Western Canada. A common problem encountered by facility operators and contractors is not allowing sufficient time for the planning and approval process which leads to unsuccessful or postponed projects. This paper will explain the series of events that must be followed to achieve a hassle free project.

Sludge Disposal Methods:

1. Ocean dumping
2. Sanitary landfilling
3. Incineration
4. Permanent lagoon storage
5. Land application

Of these disposal methods, the only way of re-utilizing and conserving the useful components of sludge is through its application to land as a fertilizer (Mathews, 1980). This method is also consistent with the objective of disposing of sludge in an environmentally acceptable manner. For this reason we shall concentrate on this method of sludge disposal. It can be used for the biggest or smallest wastewater system and is very well suited to the sludge lagoons found all over Western Canada.

Potential Benefits of Land Application of Sludge

Municipal sewage sludge contain most, if not all, of the elements required by plants and being substantially organic by nature, they are the source of organic matter when added to soil (Milne and Graveland 1973). Many sludge-borne nutrients are organically or inorganically bound and are released gradually in plant-available forms by soil processes. This is particularly important in the case of sludge-borne organic nitrogen, which may be converted to ammonium and nitrate over several growing seasons. The economic value of sludge varies widely with nutrient concentrations. Recent research sets the value of dry sludge at $ 8.00 /tonne.

It is important that this by-product of your wastewater system is promoted as a valuable soil conditioner that agriculture will receive willingly. One example of this is the City of Calgary, who operate their very successful `Calgro' division. Using the more desirable method of subsurface injection, Calgary treats approximately 4500 ac. per year with sludge and has a waiting list of farmers eager to receive the free fertilizer. The reason for Calgary's success with this approach to sludge disposal, is good product information to the farmers, efficient equipment and computer planned land usage. Whether you are the operator of a large city system or a small town facility, the same principles can apply. Sludge injected correctly will have a fertilizer value of approximately $30 to $40 per acre.

If you are the operator of a wastewater system, sooner or later it will become necessary to empty your sludge holding lagoons or primary cells. We shall now discuss the process that should be followed to plan and expedite a successful project.

The Process

In the majority of projects it will be necessary to retain the services of a contractor to complete the work. Various levels of service are available, depending upon the chosen contractor. I would encourage you to demand that the contractor completes, on your behalf, all aspects of the planning phase so as to ensure a hassle free project for you, the customer. There are 5 steps that must be completed in the following order:

1. PROJECT DESIGN
2. INJECTION SITE SELECTION
3. PERMIT APPLICATION
4. METHOD OF OPERATION
5. EVALUATION AND FINAL REPORT

Step One: PROJECT DESIGN

Request submissions from competent contractors who are equipped to complete the total project.

Provide the contractor with:

A. Environmental regulations from provincial agencies. (eg.In Alberta "Guidelines for the Application of Municipal Wastewater Sludge to Agricultural Lands".)

B. Engineering drawings of the wastewater system.

C. Current county map to identify disposal sites.

D. Clear and concise instructions of what work is to be done.

E. The method of bidding the project. (ie. contract price or by the cubic meter.)

F. Method of establishing the volume, this needs to be mutually agreed to.

G. An indication of when you require the project completed. (Obtain firm date commitments from the contractor.)

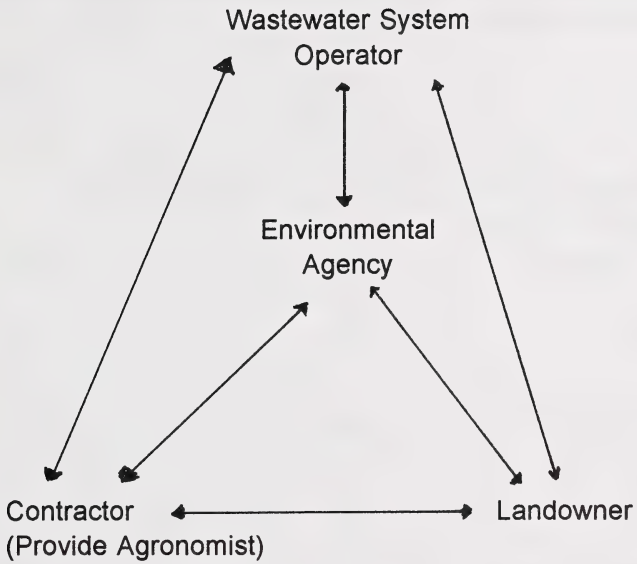
It is important that the system operator and his chosen contractor develop a close relationship with their environmental control agency. The project should be discussed fully before any decisions are reached on the method of disposal or potential land utilization sites. This will avoid frustrating delays later, due to inadequate information or incorrect interpretation of regulations.

For example: "Direct grazing of treated forage lands is not recommended for a period of 3 years immediately following application." *

*** (Table 6 - Guidelines for the Application of Municipal Wastewater Sludge to Agricultural Lands)**

"Does this include not allowing beef cattle to graze on second growth from a silage crop that was injected with sludge?"

It is just this type of detail that can stall or cancel a project because of insufficient communication between the four principles involved.



During the planning stage potential utilization sites can be discussed with your contractor. The operators local knowledge of the area and potential sludge recipients can be very useful to the contractor. The following table illustrates the minimum acceptable distances that are required when selecting disposal sites in Alberta.

TABLE 1

Minimum Acceptable Distances From Specified Features[1]

The following minimum distances are required: It may often be in the interest of the municipality and haulage contractor to exceed these to ensure public acceptance of sludge spreading programs.

FEATURE	MINIMUM DISTANCE m	PREFERRED DISTANCE m
Rivers[2],Canals[2],Creeks[2], Intermittent Drainage Courses, Lakes, Sloughs, Dugouts	30*	50
Water Wells	20	50
Areas Zoned Residential or Devoted to Urban Use	500*	800
Occupied Dwellings	60*	100
Road Allowances	10	20
Public Building Perimeters	10	30
Public Buildings	60*	100
School Yard Boundaries (School in Session)	200*	500
School Yard Boundaries (School not in Session)	20*	20
Cemeteries, Playgrounds, Parks, Campgrounds	200*	500

[1] Greater separation distances may be required based on local topographic and climatic conditions.

[2] Distances required are from the major break in slope.

* Distances can be reduced by 67% if sludge is sub-surface injected.

Step Two: INJECTION SITE SELECTION

The contractor should identify a suitable disposal site for the sludge. His choice will be influenced by environmental constraints that are designed to protect us all from irresponsible and dangerous practises. For example; in Alberta the following conditions must be met:

TABLE 2

Classification of Sites on the Basis of
Soil Characteristics, Topography and Geology

	Acceptable[1]			Not Acceptable
	Class 1 Sites	Class 2 Sites	Class 3 Sites	Class 4 Sites
pH	≥6.5	≥6.5	≥6.5	<6.5[2]
"Texture"[3]	CL,SiCL, SiL,Si,Sic L,SCL,SC	C,HC	LS,SL	Sand and gravel†
Slope% *	0-2	2-5	5-9	9
Depth to Potable Aquifer (m)	>5	3-5	2-3	<2

[1] A site falls into the lowest class represented by any characteristic.

[2] A site with a pH less than 6.5, which would otherwise be classed 1 or 2 may be upgraded by liming to pH 6.5 or higher.

[3] As determined on samples from representative soil horizons to a depth of at least 30 cm.

† Other class 4 sites include stream valleys, intermittent drainage areas and organic soils.

* Restriction of sludge application rates based on slope considerations apply only when surface application methods are employed. Slope criteria can be relaxed if sludge is applied by subsurface injection.

It is obvious that the closest sites should be considered so as to minimize transportation costs. In the majority of cases these sites are going to be owned by local farmers. It is the job of the **contractor** to educate the land owner in the advantages of sludge as a soil conditioner and obtain his permission to use the land. This may require the services of a qualified agronomist to convince the land owner that the sludge will be applied in an accurate manner that will have a beneficial effect on his land. This initial communication with the farmer is very important if a successful project is to be achieved. Once permission has been granted by the land owner, a soil sample can be obtained. The sample must be representative of the disposal site to a depth of at least 100 cm.

The next requirement of the contractor is to obtain a sludge sample from each lagoon to be emptied. The sample should be placed in a 1 litre plastic bottle that is suitable for shipping by courier service.

You are now ready to proceed with a permit application from the relevant provincial environmental agency.

Alberta:

Municipal Branch
Standards and Approvals Branch
Alberta Ministry of the Environment
4th Floor 9820 - 106 St.
Edmonton, Alta.
T5K 2J6

British Columbia:

Local Regional Office
Ministry of Environment and Parks

Saskatchewan:

Air and Land Protection Branch
Dept. of Environment and Public Safety
Walter Scott Building
3085 Albert Street
Regina, Sask.
S4S 0B1

Step Three: PERMIT APPLICATION

The contractor should be able to help you complete the application form that results in the required "Letter of Permission" or permit being issued. The application form, sludge and soil samples are then sent for analysis and consideration. If all requirements are met a "Letter of Permission" will be issued.

The most important consideration at this stage in the project is time. Most plant operators do not allow sufficient time for the previous planning steps to be completed. It is our experience that at least three months should be allowed. There are always the situations where your first choice of injection site is not environmentally acceptable. This will then require that a new site is located, possibly owned by a different farmer that will require step 2 to be repeated. In our experience it is prudent to have a reserve site already identified and sampled to avoid delays.

If a spring project is being considered we always encourage plant operators to complete the sampling the previous fall. There is often a reluctance for an operator to proceed with this step before a firm decision on the project has been made. A reputable contractor should be prepared to provide this service at no cost on a contingency basis.

The final timing consideration is that of the co-operating farmer's cropping schedule. Depending on local seeding or harvest conditions the "window" of opportunity can be very small; often only four weeks spring and fall. If summer fallow is practised in your area this will certainly extend the operating period. If your contractor has successfully completed the previous steps, your "Letter of Permission" should be issued with minimal input from you.

Depending on the results of the sludge and soil analysis, an application rate will be granted. Table 3 illustrates the various combinations permitted based on site classification and sludge type.

TABLE 3

Maximum Addition of Sludge Solids and Sludge-Borne Nitrogen for Each Site Class and Sludge Type-Single Application

Sludge Type	Solids Application Rate [1] t/ha-dry weight basis			Total Nitrogen Application Rate kg/ha			Available Nitrogen Application Rate for Surface Spreading[2] kg/ha		
	Class 1 Sites	Class 2 Sites	Class 3 Sites	Class 1 Sites	Class 2 Sites	Class 3 Sites	Class 1 Sites	Class 2 Sites	Class 3 Sites
Digested	25	20	10	900	700	400	450	350	200
Waste Stabilization Pond	10	8	5	800	600	300	400	300	150
Undigested[3]	5	4	2.5	600	500	200	300	250	100

1. For surface application a maximum hydraulic loading rate of 100 m^3/ha/day is imposed for sludge containing less than 5% solids. Allowable solids and nitrogen rates for such sludge may be achieved by making several incremental additions with the soil cultivated between each addition. There is no hydraulic loading rate restriction on sub-surface injection.

2. For sub-surface injection the maximum available nitrogen application rate is 200 kg/ha on Class 1 and 2 Sites and 150 kg/ha on Class 3 Sites.

3. Undigested sludge must have been stored for a minimum of 6 months, have a pH of greater than 12 or have a volatile solids content less than 60% of the total weight of solids.

Step 4: METHOD of OPERATION

It is important that the plant operator is aware of the different methods of sludge removal and disposal. The following is a description of the various methods available:

Sludge Removal

The objective when cleaning sludge from a lagoon is to mix it into a homogenous mixture. It may be necessary to add water back into the lagoon so that a pumpable slurry is attained. To agitate the sludge the contractor can use either:

a. Tractor powered agitator and pump

For lagoons of less than 150' width, tractor powered agitators with a built in pump are the most cost effective method of sludge agitation and removal. These units can be moved around the berms of the lagoon so that the build-up of sludge is completely agitated and removed. It is beneficial that the sludge is pumped away from the edge of the lagoon via hoses and temporary pipeline to either the injection site or a truck loading station. It is suggested that the system operator demand that this method of sludge transfer is used, so that tank or vacuum trucks are not allowed up onto the banks of the lagoon or cells. Any cost savings can be quickly lost in extensive repairs to the banks or pipework.

b. Floating dredge with cutterhead pump

When desludging large shallow lagoons it is very difficult to agitate the solids over the whole surface of the cell. In these cases a floating dredge is the most efficient type of equipment to use. The dredge can be equipped with an auger type cutter-head that is able to progressively cut into the sludge. The dredge is able to traverse laterally across the lagoon by cables or controlled by an onboard operator. The solid density of the sludge can be controlled by the speed that the dredge is allowed to attack the sludge. It is recommended that a solids density of not more than 12% is allowed or subsequent problems will be encountered when trying to unload tankers or inject the sludge. The homogenized liquid is pumped from the dredge to the lagoon bank via a floating pipeline.

Sludge Transfer

Once the sludge is successfully removed from the lagoon it has to be transferred to the injection site prior to injection. This can be accomplished by either one of the following:

a. Tank Trucks

Advantages
- Very versatile
- No limit to distance transferred
- No limit to volume per hour (just increase number of trucks)

Disadvantages
- Road bans may be restrictive
- Heavy trucks will cause damage to berms or roadways
- Can create negative public reaction due to sludge being leaked onto roads or danger of heavy traffic
- Not as economical as pipeline over short distances

b. Temporary Pipeline

Advantages
- Move large volumes of liquid economically
- No damage to berms or roads
- Good public reception - no noise or danger of traffic

Disadvantages
- Not practical over 3 miles
- Can create problems when crossing roads, railways, etc.

Injection Procedure

Just as important as observing the environmental restrictions is confirming with the land owner what his fertilizer requirements are. It would be regrettable if an otherwise successful project was spoiled because of poor communication between your contractor and the receiving land owner. An over application of sludge would result in a lodged crop and a dissatisfied farmer at harvest time. This would only detract from our goal of successful agricultural utilization of sludge.

It would be prudent for the system operator to confirm with his contractor how he controls and achieves an accurate injection rate.

There are three methods of sludge injection in common use:

a. Terra-Gator Injector

This equipment is a 4 wheel drive high floatation application. It is normally equipped with a 12 m^3 tank (2500 gals). Hydraulically controlled injectors can be adjusted to a depth of 50 cm. for various soil conditions.

Advantages	- Low soil compaction due to large tires
	- Very good traction in wet conditions
Disadvantage	- Slow if only one unit is used
	- Very expensive to operate and rent
	- Highly paid operator required

b. Tractor Drawn Injector Tanks

Various sizes of "honey" wagon vacuum tanks have been fitted with rear injectors.

Advantages	- Very useful on small irregular fields
	- Cheap to own and operate, any suitable tractor can pull it.
Disadvantages	- Difficult to control injection rates
	- Poor on soft or hilly land
	- High level of soil compaction

c. Draghose Injector Tractor

This very efficient method of sludge injection uses an injector bar mounted behind a four wheel drive tractor. Connected to the injector bar is a 1300' hose that is dragged behind as the tractor moves across the field. Sludge is pumped continually via a pipeline and injection rates of up to 270 m^3 (60,000 gals) per hour can be achieved.

Advantages	- Continual injection of sludge
	- Very accurate application rates
	- Low soil compaction
	- When combined with pipeline, most economical method
Disadvantages	- Not suitable for fields of less than 40 acres

Step 5 EVALUATION and FINAL REPORT

It is important to both the operator and the contractor that a clear understanding of how the project is progressing is reviewed daily. A routine visit to the site by the operator will help the contractor fulfil his obligations.

On completion of the work the contractor should submit a written report to the municipality describing his performance and any problems that the operator should be aware of.

The operator of the wastewater system will then be required to inform the provincial authority who issued the environmental permit that the project has been successfully completed.

CONCLUSION

Agricultural utilization is the only way of re-utilizing and conserving the useful constituents found in sludge as a valuable fertilizer and soil conditioner.

If the five steps described in this presentation are followed, what at first appears a daunting task, can be a logical and environmentally sound project. The two factors that must be stressed: allow at least 3 months for the planning and approval process and demand that your contractor is involved in all steps of the project.

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Water Treatment in Zimbabwe

Guy Jette, Head Operator
City of Fort McMurray
Water Treatment Plant

The Republic of Zimbabwe, formerly known as Rhodesia, is located in the heart of the Southern African sub-continent between two great river systems; the Limpopo in the South and the Zambezi in the North. Zimbabwe is a land locked country that is bounded by four neighbours; Zambia to the North; Mozambique to the East; South Africa to the South; Botswana to the West. Zimbabwe is slightly smaller than the province of Newfoundland (including Labrador), and extends over 750 km from North to South, and 800 km from East to West.

The technical and community exchanges, that the City of Fort McMurray was involved with, were sponsored by the Federation of Canadian Municipalities and the Canadian International Development Agency. Before I continue further into the session, I must stress that these exchanges were not hand-outs, but a co-operative and co-sponsored initiative in conjunction with the African community.

The program that I was involved with was called "Africa 2000 - The Municipal Response". It was a technical exchange, which consisted of providing a basic water treatment laboratory. The second exchange was a community based project which involved the financing and construction of a market place.

Therefore, after a 22 hour flight and a 4 hour drive - Welcome to Kwe Kwe, Zimbabwe. The municipality is located in the heart of Zimbabwe. It is a mining community (i.e. gold, chrome, iron ore). Its' population is approximately 85,000 persons.

The municipality, by Zimbabwe law, is responsible for its residents from birth to death. The municipality also provides the following basic services:

> Water/wastewater treatment, provision of houses, refuse collection, day cares, primary and secondary schooling, clinics (with one hospital)

With all those expenditures, there must be a good source of revenue. They get this revenue by operating their own pubs. Kwe Kwe's surface Water Treatment Plant was built in three stages. The first stage was built in the 1950's, the second in 1965 and the third in 1978 (all with the help of the Dutch government). Therefore, the plant is now known as Dutchman's Pool.

The plant employs 1 superintendent, 1 foreman, 2 operators, 4 ground keepers and a security guard. All of these employees and their families live on site. The raw water source is from a diversion project and it originates from the Zambezi River, which is approximately 450 km N.W. of Kwe Kwe. The municipality is required to pay the central government for the amount diverted.

The treatment plant consists of 1 river intake with 3 submergible pumps with a rated capacity of 19,000 M /day. The raw water is statically mixed with alum and then a flocculent aid is applied. The water is then settled in a sedimentation tank. Filtration is conducted by 3 gravity dual media filters, which consists of anthracite and sand. The filtered water was then disinfected with chlorine and Ph adjusted with lime and distributed into the distribution system.

The one thing that I could not get over is the use of asbestos (i.e. wear plates, distribution system and on roofs of homes). The distribution consisted of 1 water tower with a capacity of 15,000 M . Because of the drought being experienced, the plant would operate between the times of 6:00 a.m. - midnight or until (19,000 M would be produced).

The operations staff were somewhat trained. The degree of knowledge was dependent on the position held. However, technical knowledge was low. The staff would easily accept what was told to them and that would become law. Example: Polymer salesman would instruct staff in method of mixing and feeding of material. Which is okay - But, when I calculated the feed rate, they were feeding 8 mg/l. This polymer had a world health organization warning of maximum 1.5 mg/l.

After saying that, I feel the operators were doing a fairly good job, considering they had absolutely no way of measuring their performance through water quality controls or parameters. Therefore, I was asked to provide a basic water laboratory to Kwe Kwe. The community fears, prior to this project, was the contamination and the spreading of cholera.

It all started in the early part of December 1992 when I made contact with the African municipality. I remember that first phone call. Man...it created a ruckus. You could hear doors slamming, people running on the concrete floor and total excitement in the voice of the town engineer (i.e. Where are you? Are you here yet? When are you coming?).

After the usual greetings, I began to ask a number of questions to determine their actual need requirement. However, the usual response I received was: "We would appreciate what you could bring". Well! It appeared that I would not get too far this way. So the next avenue was to try to reach both the City of Harare, the University of Zimbabwe and the World Health Organization. From these sources I was able to determine what would constitute a basic water lab in an African municipality of 85,000. The next step was to call tenders for equipment and consumables. This took approximately 6 weeks, at which time materials were then crated and eventually sent overseas. However, problems did arise from the Zimbabwe treasury as they were going to charge a 70% duty on all goods. I couldn't believe it! How can anyone charge tax on foreign aid? After learning of this situation, I contacted our Canadian High Commission in Harare for assistance (HELP!). It took nearly 9 weeks for clearance. Finally!! - Mrs. Betty Osmond and I departed for Zimbabwe on May 1/92.

The training went extremely well. The 4 operators were overwhelmed by the equipment and materials that they received. The total weight of the crates exceeded 1,000 kg. The most important aspect of this program was to do the training that was required to be done and not to overstep your boundaries and secondly, earn their trust and respect. (I did this by showing them photographs of Fort McMurrays' Water Treatment Plant, giving them pens, pencils, ball hats and solar calculators).

My students were extremely apprehensive and eager to learn. They would not touch anything without asking first. They had a gift of memorizing everything I said. The training consisted of hands-on and a lot of repetition on the operations, maintenance and re-ordering of stock. By the end of May they were conducting the following parameters:

> Ph, Alk, turb/th/ca/mg/mn/fe, total chlorine, free chlorine, apparent colour and jar testing

All equipment was confirmed of availabilities of repairs in Zimbabwe or neighbouring countries. The lab was self-contained for 16 months for conduction of the above mentioned parameters 12 times a day/ 365 days/year.

	Monthly Average	Treated/when started	Treated/month
Turb.	230 NTU	12 NTU	2 NTU
A.Colour	520 CU	17 CU	4 CU
Ph	7.9	12	8.0
Alk	60 mg/l	72 mg/l	68 mg/l
th	52 mg/l	65 mg/l	60 mg/l
ch	40 mg/l	50 mg/l	45 mg/l
mg	12 mg/l	15 mg/l	15 mg/l
mn	0.002 mg/l	trace	trace
fe	0.2 mg/l	0.1 mg/l	trace

In closing:

I believe that this was an opportunity of a life time and if offered, I would do it all over again.

I would like to thank all those persons who made this exchange a success:

- Joanne at Fischer Scientific
- Steve at Hach
- Don at Cratex
- Don at Prairie Chemical

Using Particle Counting To Compare Filter Media In A Drinking Water Treatment Plant

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Department of Engineering and Environmental Services
City of Calgary

INTRODUCTION

Particle counters both count and size particles in a fluid medium, usually one particle at a time. With sampling configurations of discrete (individual) sample analysis or on-line sample analysis, particle counts have proven a valuable addition to water treatment plant monitoring for a variety of applications (Hargesheimer, et al., 1992a). At the City of Calgary's water treatment plants, particle counters provide information especially pertinent for clear waters where low turbidity readings make it difficult to distinguish between optimum and non-optimum treatment conditions (Hargesheimer, et al., 1992b, l991 Lewis l989, Lewis and Manz l991,Lewis et al., 1991).

In this study, an on-line particle counter was set up in a novel configuration and was employed to compare the performance of two dual media (sand and anthracite) rapid rate filters. One filter contained 20 year old dual media. Media in the other filter bed contained two month old media with different specifications than the original media. Both filters were operated at 1.9 USGPM/ft^2 (9 ML/d) and both were operated at 4.9 USGPM/ft^2 (25 ML/d).

BACKGROUND

The first stage of the Bearspaw Water Treatment Plant, completed in 1972, has fourteen 40' x 24' filters. These filters were originally installed as seven sand filters and seven dual media filters. Two filter types were included to lend plant operators maximum flexibility in treatment strategies. The seven sand filters were converted to dual media filters in 1977 in order to increase plant production and to enable longer filter run times.

Although performance of the filter media was adequate for requirements of the late 1970s, the filters did not function up to the expectations of the 1980s. Additional filter material was added to the filters, but filter performance continued to be lower

than hoped for. A high degree of intermixing between the sand and anthracite was evident (Hambley Engineering Ltd., 1992). When the second stage of the plant was opened in 1984, filters in the new stage produced water of measurably higher quality than did the filters in the first stage. This made the need to improve the performance of the Stage I filters obvious. In addition, production demands on the entire Plant have increased and the capacity of the Stage I plant is more important than ever. Replacement of filter media in the original plant was proposed as a way to improve both quality and quantity of water produced. Prior to changing the media in 14 filters an evaluation of new media in a single filter was commenced.

MATERIALS AND METHODS

On the test filter, a sieve analysis was conducted, the media was completely removed, the filter's under drain system was inspected, and new filter media was installed (Hambley Engineering Ltd., 1992). The specifications of the original media, results of the sieve analysis of the existing media, and specifications for the new media are summarized in Table 1. After numerous backwashes, the filter was operated normally for more than two months prior to starting the comparison study.

The test filter was compared to a filter containing existing media located directly across the filter gallery. For the results reported here, the two filters were operated in parallel, both at 1.9 USGPM/ft^2 (40% of design flow rate) for 55 hours and both at 4.8 USGPM/ft^2 (100% of design flow rate) for 25 hours. These filter flow rates correspond to 9 ML/d and 25 ML/d, respectively. Filter runs were terminated on length of time in service (maximum 55 hours run time), turbidity (maximum 0.25 NTU) or loss of head (maximum 1.8 m) criteria.

Filtered water quality was measured using monitoring equipment installed as described below. Particle counts and turbidity were selected as the measures of water quality with which to compare the performance of the two filter media. These instruments were set upon an on-line configuration on the fitter effluent header of both filters as shown in Figure 1. A single particle count sensor and a single turbidimeter were used to monitor both fitters in order to eliminate any discrepancies due to inter-instrument differences.

Water from each filter effluent header was directed into a manifold. A solenoid-actuated valve sent flow from either filter through a stream splitter and through a particle count sensor (and associated downstream flow controller) and a parallel turbidimeter. Flow through the manifold was switched between filters

hourly on the hour. On the half hour, the particle counter conducted a 30 second count. Simultaneously, a data logger polled the turbidimeter, a filter now rate meter, and loss of head meter. On this schedule, one reading of all parameters was conducted on each filter effluent every two hours.

Particles were counted using a Model Micro-LPS16 particle counter, a Model IMOLV2.0-150 sensor, and Facility Monitoring Software package (all from Particle Measuring Systems, Boulder CO). The number of particles per ml greater than 2.0 µm was enumerated. This is the lower size limit of detection for the light obscuration sensor. Flow of sample through the sensor was maintained at the calibration flow rate of 60 mL/min using a liquid educator downstream of the sensor. A 30 second particle count was conducted and counts corrected to "per mL"; the cumulative total number of particles greater than 2 µm per mL (NP>2 µm/mL) is reported. Quality control procedures were followed (Lewis et al.,1992).

Turbidity measurements were made with a Model 95T analyzer, Model 8220 sensor (Great Lakes Instrument Co, Toronto, ONT). The data logger was a Model LD8170 (Lake wood Systems Ltd., Edmonton, AB).

RESULTS AND DISCUSSION

During the five day period over which these two filter run comparisons were conducted, raw water turbidity was 1.4 NTU, pre-chlorine dosage was 0.9 - 1.0 mg/l, and aluminum sulfate was being added at 16 - 19 mg/l. At the start of each comparison run, filters were backwashes, filtered to waste for 20 minutes or until the filtered water turbidity decreased to an acceptable level. For these experiments, the filter run was considered to have started when the filter:to-waste period ended and the filter was producing water into the plant clearwell.

Low Filter Flow Rate Evaluation

In the first comparison, both filters were operated at 1.9 USGPM/ft^2 for 55 hours. For both filters, the filter run was terminated using the "length of service" criterion; neither turbidity nor loss of head criteria had been exceeded. The test media out performed the existing media throughout the entire 55 hour period.

Filtered water particle counts were very low in the test media filtered water at all times. (See Figure 2.) The NP>2 µm/ml was 26 when the filter run started, and

showed a gradual improvement in filtered water quality, decreasing with filter run time to as low as 2 after 52 hours of operation. Turbidity of the filtered water was steady, ranging between 0.04 and 0.07 NTU. Interestingly, the ripening of this filter indicated by the particle counts over the first 12 hours was not reflected in turbidity measurements. This supports the improved sensitivity of particle counts over turbidity for very clear waters.

The water quality produced by the existing media at 1.9 USGPM/ft^2 was not as good as that of the new media. although at this very low filter rate both filters produced good quality water. The NP>2 µm/ml from the existing media filter ranged from 153 to 15. (See Figure 2.) The NP>2 µm/ml decreased gradually for the first 45 hours of the filter run then began to increase. Turbidity readings also showed a gradual improvement in filtered water quality during the run, decreasing from 0.15 NTU (when the filter was returned to service after backwash) to 0.07 NTU (at 45 hours).

High Filter Flow Rate Evaluation

In the second comparison, both filters were operated at 4.8 USGPM/ft^2 for 25 hours. In this test, the filter runs were terminated on the basis of filtered water quality greater than 0.25 NTU, which both filters exceeded. In this comparison, particle counts showed that the new media produced better water quality for the first 15 hours of the filter run and equivalent to slightly lower quality for the final 12 hours of the filter run than did the existing media. Turbidity readings indicated that the new media produced better water quality than the existing media for the entire filter run.

Particle counts in water produced by the new media ranged from an NP>2 µm/ml of 10 (early in the filter run) to 1637 (at 25 hours of service). (See Figure 3.) Turbidities ranged from 0.05 NTU (early in the filter run) to 0.23 NTU (at 25 hours of service). Both particle counts and turbidity were steady for the first 7 hours of the filter run and then increased throughout the remainder of the run.

In the filter containing the existing media; NP>2 µm/ml were 130 when the filter returned to service, decreased to 85 at 3 hours of filter run time, and increased to 909 at 25 hours. These NP>2 µm/ml are higher than those of the new media for the beginning of the filter run but are lower than those of the new media for the end of the run.

CONCLUSIONS

In the low flow rate filter run described here, particle counting provided a more sensitive and consistent measure of water quality than did turbidity. In the high rate filter run, during which water quality was not as good as the low rate run, both particle counting and turbidity were useful. Based on particle count results, the new filter media produced better water quality than the existing media at low filter flow rates (1.9 USGPM/ft^2), and equivalent to slightly lower water quality at high flow rates (4.8 USGPM/ft^2).

The on-line configuration using one particle count sensor and one turbidity meter for both filters under evaluation worked well. However, the switching of sample sources between filters to the sensing devices (and associated time required to stabilize flow) limited the frequency of taking particle counts and turbidity readings. In this study, more information could have been gained if a light scatter particle count sensor with a submicron size limit of detection had been use. Since smaller particles are more numerous than larger particles, many more particles would have been enumerated, enabling a wider variety of statistical manipulations on the data.

ACKNOWLEDGMENTS

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	Effective Size (mm)	Uniformity Coefficient	Specific Gravity	Depth (in.)	Angularity
ORIGINAL MEDIA					
Anthracite	.85-1.0	1.72	unknown	18	
Sand	.45-.55	1.54-1.73	unknown	12	rounded
EXISTING MEDIA					
Anthracite	1.13	1.42	1.55	18	
Sand	.56	1.77	not <1.6	12	rounded
NEW MEDIA					
Anthracite	1.0-1.1	1.35	1.33-1.4	20"	
Sand	.48-.56	1.4	2.65	14	angular (crushed)

Table 1: Specifications of filter media in the Bearspaw Water Treatment Plant. (Data from Hambley Engineering;1992.) Performance of new media was compared to that of existing media.

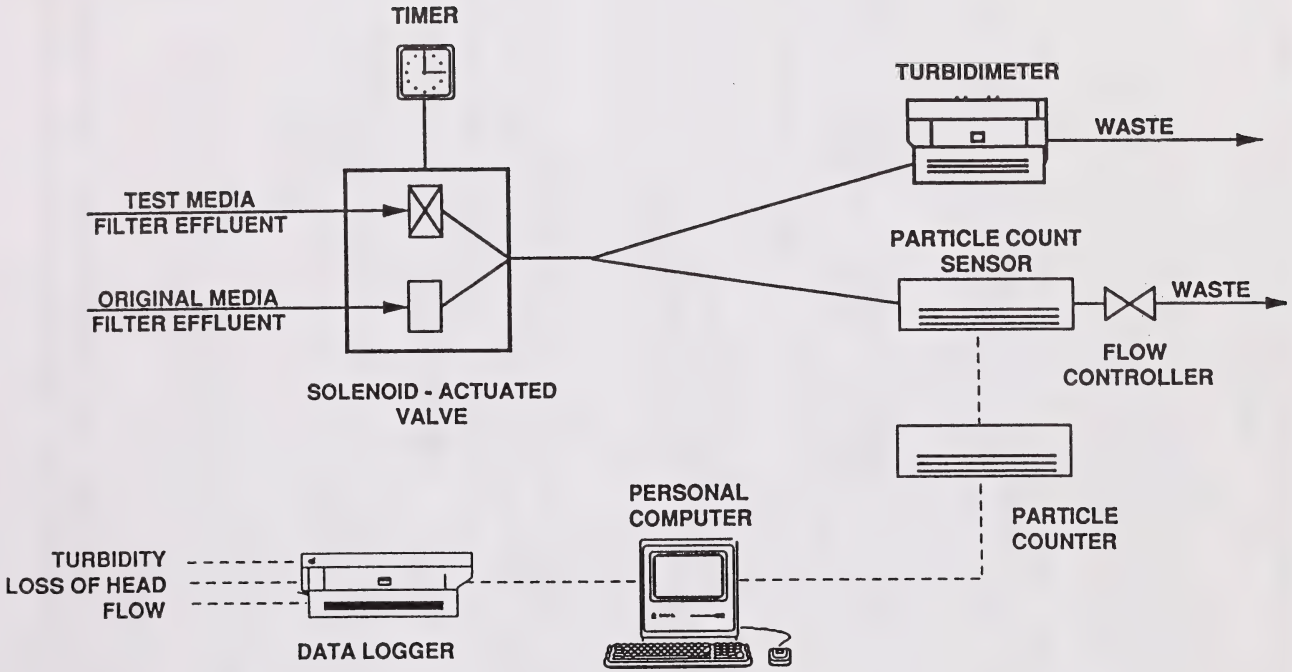


Figure 1 **On-line set up for monitoring particle counts, turbidity, loss of head, and filter flow rate. Solid line indicates flow of wat, dotted line indicates flow of data.**

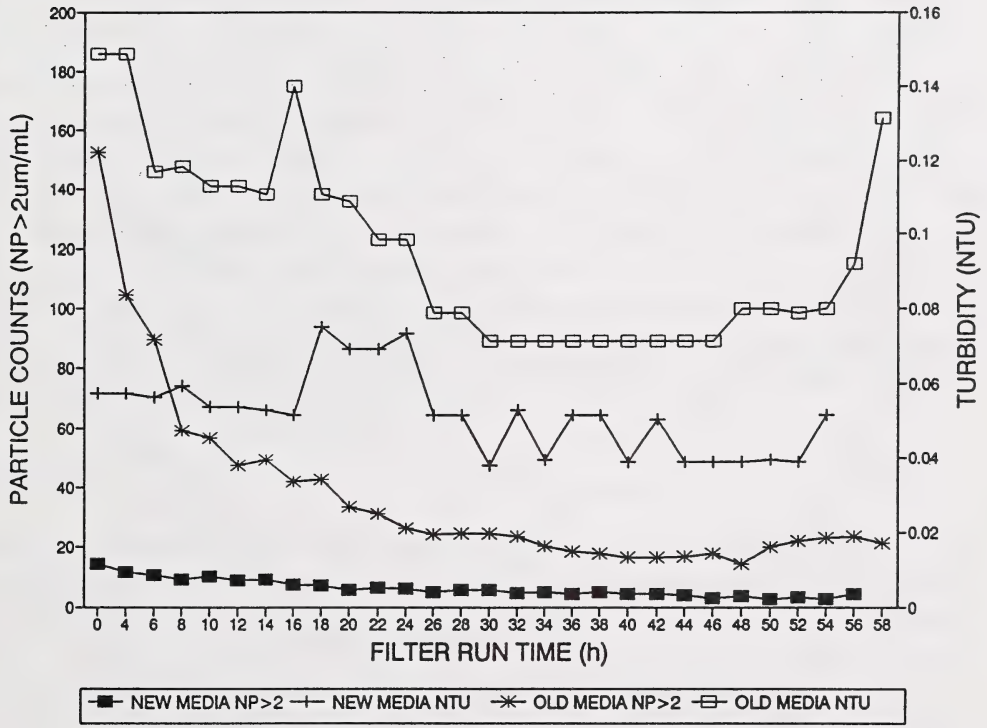


Figure 2 **Particle counts and turbidity readings for water produced by orginal and test media at 1.9 USGPM/ft^2.**

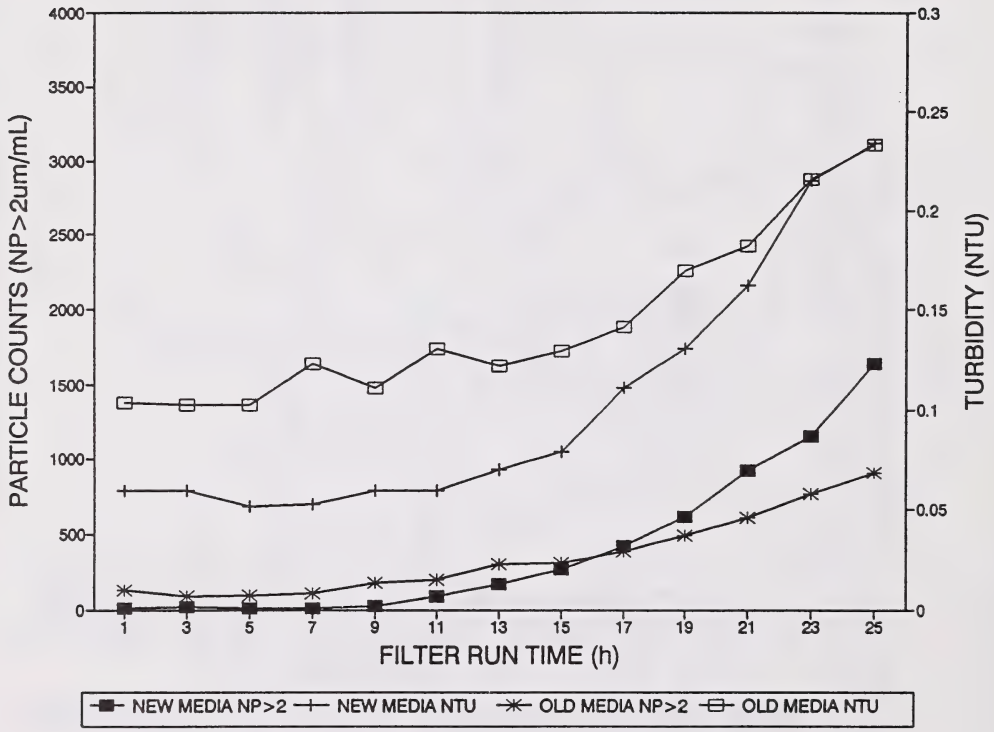


Figure 3 **Particle counts and turbidity readings for water produced by orginal and test media at 4.8 USGPM/ft^2.**

Desludging & Installing Aeration & A Floating Intake in a Raw Water Reservoir

Brent Applegate
Water Treatment Plant Operator
Wandering River, Alberta

Introduction

In July of 1992, the 28,00 cubic meter raw water storage reservoir at Wandering River underwent a complete draining and desludging of all sediments and organic to restore the bottom and side slopes back to the original condition of the clay liner. While the reservoir was dry, a floating intake and aeration system were installed. The silt had been accumulating since the reservoir was originally built in 1980, and was distributed to a depth of between 2 and 3 feet thick on the bottom floor. This encouraged a thick bed of weeds to grow at the bottom, and these weeds along with a thriving fish population were causing some serious taste and odour problems. The sediment had necessitated a 3 foot extension to be added to the existing intake by a diver a better set up was badly needed. Algae blooms in the summer were also a creating a taste and odour problem, with pH levels jumping from a normal 8 up to 9 or more. An aeration system was needed to address the Iron (Fe) and Manganese (Mn) problem in the winter. Fe an Mn levels would go through the roof once ice covered the reservoir and D.O levels dropped..

Desludging

The original specifications called for the desludging of the slit sediments to be removed by the use of a large solids-handling pump after dewatering the reservoir. These sediments were to be pushed by a small bulldozer to a sump, and pumped to a receiving area in an adjacent wooded area. This is the common method in use by the companies who specialize in desludging reservoirs. However, the local I.D. council wanted to allow any local contractors wishing to bid the job the opportunity to do so, and therefore left the method of sediment removal at the discretion of the successful bidder. The lowest tender submitted was Korchuk Construction from Lac La Biche and they were awarded the contract. Another $3,000 was spent on engineering and overseeing, of the project. Korchuk began by pumping the water out of the reservoir, and immediately encountered a problem of small stickleback fish which turned out to be the perfect size to plug off the .64 cm holes in the pump intake screen. This called for double screening of the intake and lots of pump cleaning to finish pumping the water out of the reservoir, all other remaining fish was

left to be hauled to the land fill.

A sump was dug for the pump by the bulldozer, and in order to dewater the reservoir the sediment was pushed into a large berm. The water was chased to the sump as the other end of the reservoir was being scraped down to the clay liner. By keeping the sediment berm moving towards the other end of the reservoir, the part of the reservoir that had already been cleaned would remain clean even in a rain storm as the berm would protect the clean portion from filling up with sediment. The bulldozer pushed the sediment to a large track hoe, which then moved the sediment to a platform 3/4 of the way up the side slope of the reservoir. A second back hoe then picked up the sediment from the platform and loaded it onto trucks to be hauled to a large pit dug beside the reservoir for this purpose. When the reservoir was finished, this pit was capped with soil originally dug out of it. This process worked very well, and the entire desludging job was completed by a five man crew in four days.

The most important factor in determining how well a reservoir desludging job will go is the condition of the clay liner. The procedure outlined above, or a more traditional method using one of the existing desludging companies will only be successful if the clay liner originally built for the reservoir was compacted to acceptable standards during the initial construction of the reservoir.

At the same time that we were desludging our reservoir in Wandering River, our neighbours in Plamondon had hired a desludging company to do their raw water reservoir, and had to abandon the attempt. The clay liner in the Plamondon reservoir had not been compacted properly when built, and the clay had become saturated with water, this left no base for the crews to work from. On a well compacted clay base, we were able to drive pick-ups, or any other equipment into the bottom of the reservoir an hour after removing the sediment. The Plamondon reservoir project had no choice but to abandon the desludging of the reservoir, and they were told their only option would be to reconstruct the clay liner in the reservoir. Plamondon ended up having to pay the majority of the contracted price with no desludging accomplished.

Floating Intake

A floating intake allows the intake water to be drawn from the clearest zone at any given time. This zone changes depending upon the water level of the reservoir,

time of year. A fixed intake can never deliver the benefits of increased flexibility a floating intake does, if your fixed intake is too high, it limits the depth of water you can draw down to before intaking surface scum. If your fixed intake is too low, you have water quality problems as the Mn an Fe tends to settle out on the bottom of the reservoir. Accumulation of silt deposits on the bottom are frequently disturbed by thermal layering, this can result in higher colour and turbidity readings at the bottom.

To build the floating intake, we simply connected a 150 mm PE series 80 potable water line 50 m long to the existing PVC incoming pipe. The connections were made using steel pipe bends and flanges, and a robar coupling, and encasing all connections up to the 50 m of series 80 pipe, in concrete. At the intake end of the pipe, a stainless steel Johnson screen was installed, and this is connected by a adjustable poly rope to a floating 30 gallon polyethylene barrel. The bottom of the intake screen flange is attached to a poly rope which runs through a steel loop poured in a concrete slab directly underneath the intake, on the bottom of the reservoir. The rope then runs up to a post on the bank, and the intake drift may be adjusted from there. The distance from the top of the intake screen to the water surface set at 1.5 meters at the present time. Concrete pipe weights were placed every 5 meters along the 50 meter run from the screen end of the intake to where the line goes underground and into the Water Treatment Plant. When we first started using the floating intake, we had to drill a small 30 cm hole in the top of the highest point of the line to allow the air to escape, and the line to sink below the reservoir surface. The cost of installing the floating intake including all labour and materials was around $10,000.

Aeration System

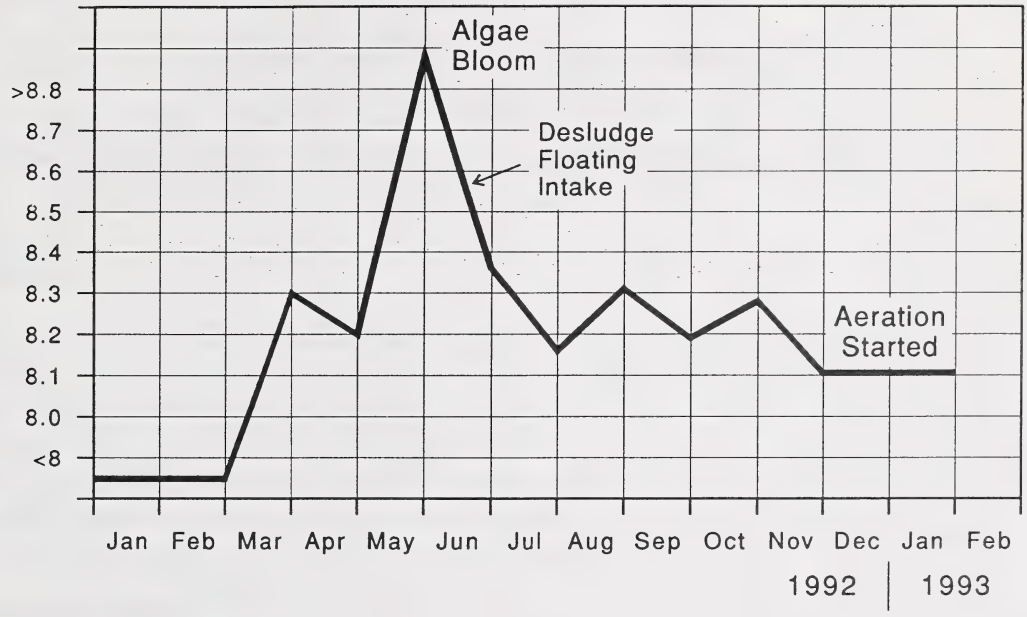
The most cost effective improvement made to the quality of water was the installation of the aeration system. The total installation cost was around $3,500, with $1,500 going towards the Gast P140J compressor/blower, and the 2.5 cm copper and poly air line, and the other $2,000 going towards dirt work. A trench was dug from the bottom side of the reservoir closest to the WTP into the WTP. Copper tubing was then buried from the plant to the reservoir, this was a precaution to keep the line below the frost level incase the check valve failed, and allowed water to fill the air line from the reservoir. Where the copper line came out and into the bottom of the reservoir, a check valve was installed, and the air line switched to polyethylene tubing which was run 200 feet down the reservoir. Copper was used for the first 100 feet from the compressor to the reservoir to allow better withstanding of the heat generated by the compressor.

A level clay beam was shot in with a transit and built down the centre of the reservoir by the bulldozer. Hollow masonry building blocks were spaced every 0.6 meters down the centre of the clay beam, and the 2.5 cm poly line was then fed through the openings in the blocks down the middle of the reservoir, to keep the air line from floating to the surface. Care was taken to ensure that the blocks were kept at the same elevation throughout so as not to effect the air dispersion by having different water pressures on different parts of the hose. We consulted with our engineers to determine the size and spacing of our air outlet holes. This was complicated computation involving; size, force of the blower, size and length of the aeration line, 2.96 kpa of water, etc. Based upon this calculation we drilled 60 2.5 cm holes in top of the air line, spacing them every meter down the line. Unfortunately, once we fired the system up under 4.26 meters of water, we discovered that the air only had enough pressure to come out of the first 30 holes. Pressure was such, that we had large swells on the surface of the water at the beginning of the line and depleted to small swells in the middle where the floating intake was located where we really needed the aeration.

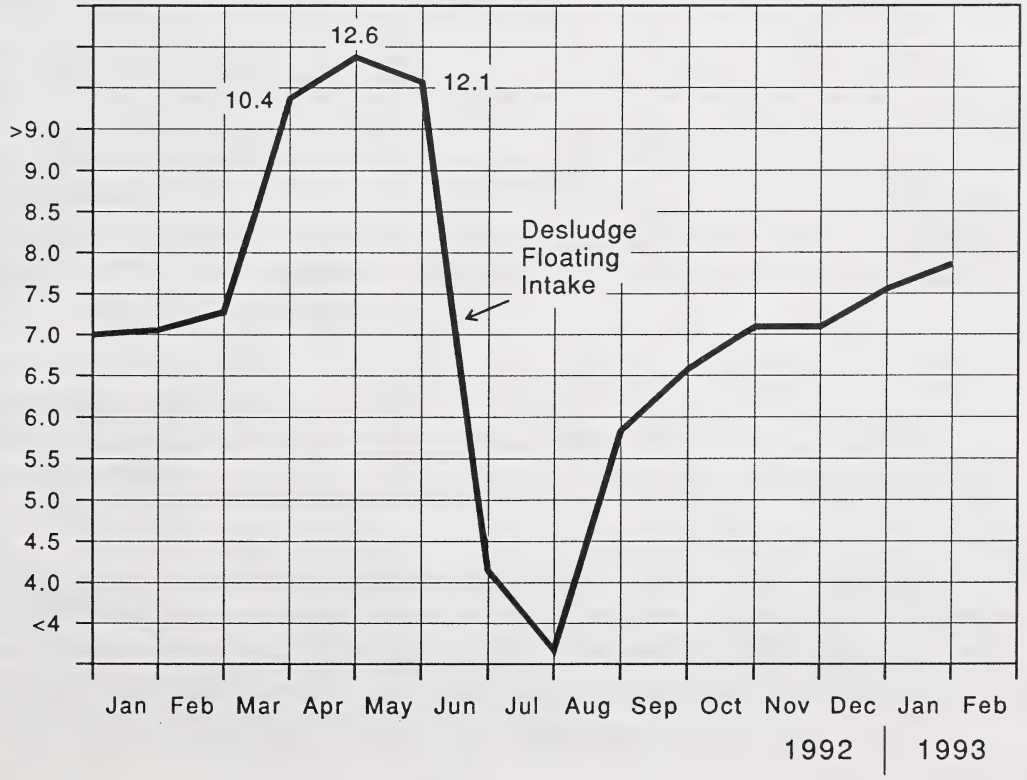
We were able to correct our calculation by factoring in the variable **D**. After factoring in **D** we were able to reduce the number of holes to 30, and to space them in such a way that there was only a hole every 5 meters or so at the beginning of the line where the pressure was the strongest, allowing the 1 meter groupings to let more air out around the floating intake. I would advise anyone wishing to learn more from our efforts to begin with 0.15 cm holes every two meters, and end up with 0.31 cm holes every 0.5 meters around the floating intake. That way you can avoid factoring in the **D** variable and plugging up holes with stainless steel screws.

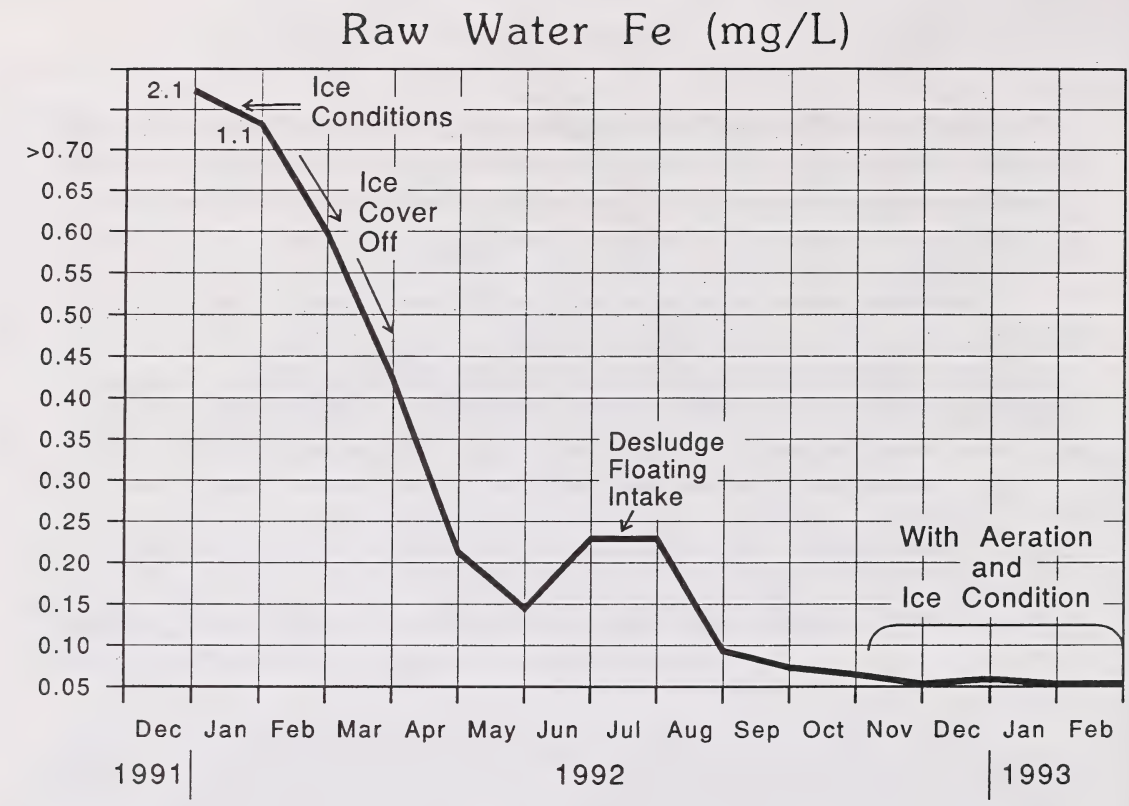
The aeration has had a remarkable effect on our raw water Fe and Mn levels. The water stays open an extra month in the fall, and the ice opens a month early in the spring. Where we used to have Fe levels between 1 and 2 mg/l, we are now down to below 0.1 mg/l under full ice cover. Where the Mn levels used to be over 0.1 mg/l we are now running below 0.04 mg/l under full ice cover. Please see the attached charts which highlight this change. If additional information is desired regarding this project, please feel free to phone the writer of this article at 403) 771-3914.

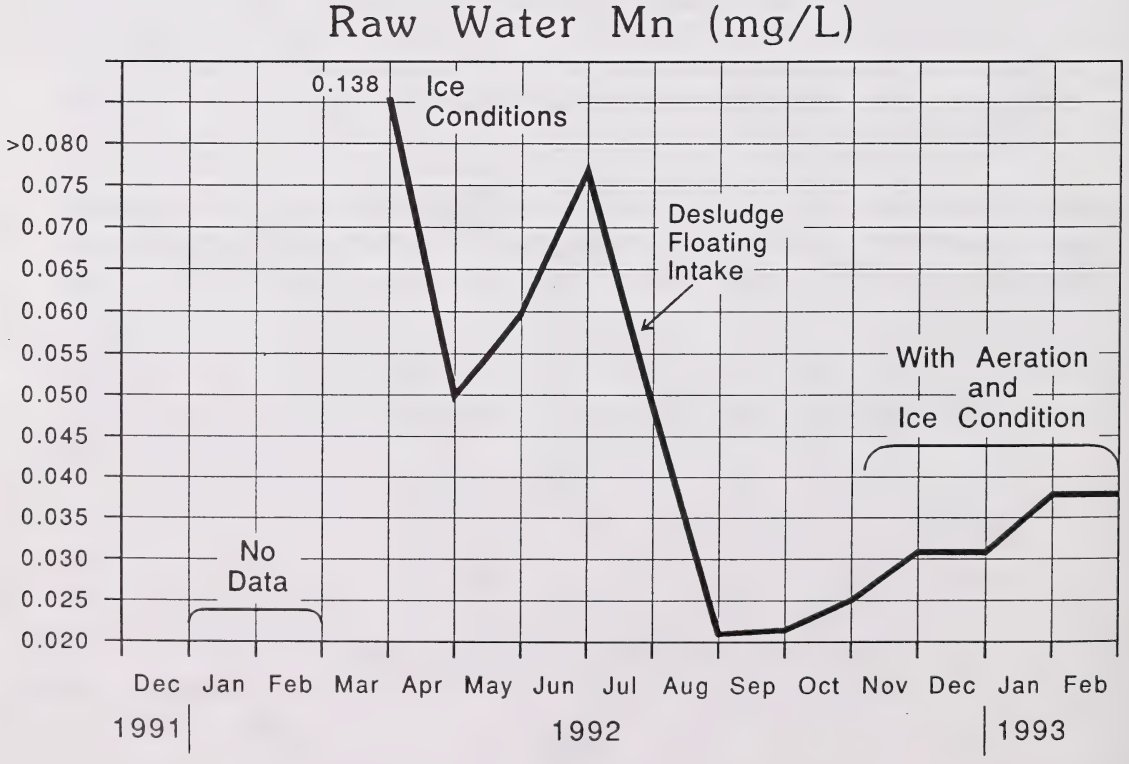
Raw Water P.H.



Raw Water Turbidity




Raw Water Fe (mg/L)
2.1
1.1
Ice Conditions
Ice Cover Off
Desludge Floating Intake
With Aeration and Ice Condition
>0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb
1991
1992
1993


Raw Water Mn (mg/L)
0.138
Ice Conditions
Desludge Floating Intake
With Aeration and Ice Condition
No Data
>0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb
1991
1992
1993

Design, Operation and Maintenance of Water Distribution Reservoirs

Roderick M. Facey, Ken J. Richardson, Clayton Ernst, Karen M. Emde & Daniel W. Smith

Abstract

The City of Edmonton has developed a considerable amount of expertise in the operation and maintenance of water distribution reservoirs. Operating strategies and objectives have been developed to maintain a high quality of potable water through the use of a Quality Control and Assurance program. Discussed as part of this paper, is the City's five year reservoir maintenance program. Integral activities of the maintenance program include shutdown scheduling, inspection and cleaning, biological and water quality testing, and field disinfection.

Introduction

The City of Edmonton operates two water treatment plants to supply an average of 320 ML/D of treated water to a population of approximately 730,000 people, of which 585,000 are City dwellers. The source of raw water for the City is the North Saskatchewan River. Two water treatment plants, both involving clarification, softening, recarbonation and rapid sand filtration, are used to produce potable water. Both plants involve a three stage treatment process and cannot tolerate large or frequent variations in throughput. The relatively complex treatment process does not allow production rates at the water treatment plants to be varied to echo changes in demand. Instead, these variations must be met by numerous reservoirs which have been strategically located throughout the City.

The City of Edmonton has two storage reservoirs located at each of its water treatment plant sites and at ten other sites located throughout the City. The total volume of water stored when the reservoirs are full is 727 ML, of which 74 ML is reserved for fire protection. The storage available for balancing variations in demand is 653 ML.

The topography of Edmonton is relatively flat and does not lend itself to gravity reservoirs. In addition, the climate is unsuitable for elevated water storage tanks due to the problem of freezing. Consequently, Edmonton's reservoirs are located at similar elevations to their supply zones. To regulate flow into and out of the reservoirs requires pumps, valves and control systems.

Operation

One of the most important criteria in the operation of a water distribution reservoir is the capability to manipulate the fill rate to control the storage volume so as to be able to respond to different demand conditions. The City of Edmonton to control the filling of its reservoirs uses a control valve which is positioned by a pulsed output controller which in turn is regulated by a magnetic flow meter (Figure 1.0). This type of valve control has several advantages over the more traditional methods of altitude valve control based on level, or multiple set fill rates based on level and declining storage. The most important advantage is the infinite variable fill control providing the operational flexibility to respond to changing demand and supply conditions. Another advantage is the system is responsive and allows for accurate control for balancing of storage volumes.

Energy efficient Variable Speed Drives (VSD) are used extensively in City reservoirs to provide a high degree of supply pressure control and a wide range of operational scenarios. The benefit of using VSDs has been most pronounced in reservoirs located in secondary zones. The VSD pumps provide for a wide range of flow rates with high energy efficiency while being able to adjust to increases over time in the system head loss from age and expansion. For example, the City has observed that in the early stage of development of a secondary pressure zone the required operational band to satisfy service levels of a customer at the highest elevation may be only 30 KPa. However, as the network is expanded over time the system head loss may increase to now require an operational band of 100 KPa, a difference between winter low and summer high demand or fire demands. The City has found the combination of both variable and fixed speed pumps to be very cost effective in the operation of its reservoirs.

Reservoirs can serve as primary or secondary supply storage. Primary supply reservoirs support the water treatment plants during periods when the demand exceeds the treatment plant production capacity. Secondary supply reservoirs supply water to areas of higher elevation which cannot be adequately serviced directly from the source or from the pumping facility at the treatment plant site. The storage capacity of a reservoir will vary depending on the type of service area and the expected number of days in which the supply capacity will be consecutively exceeded. City reservoirs are designed to have a storage volume for fire protection, daily and hourly balancing and to satisfy a 5 day consecutive high demand. However, to avoid depleting substantially the overall City storage volume during periods of extended high demand or operational problems, the City has developed a set of Demand Management Measures. These Demand Management Measures

become effective when the overall City storage volume is depleted to a value of 65 %. Summarized in Table 1.0 is the City's different Demand Management Measures for declining storage volumes.

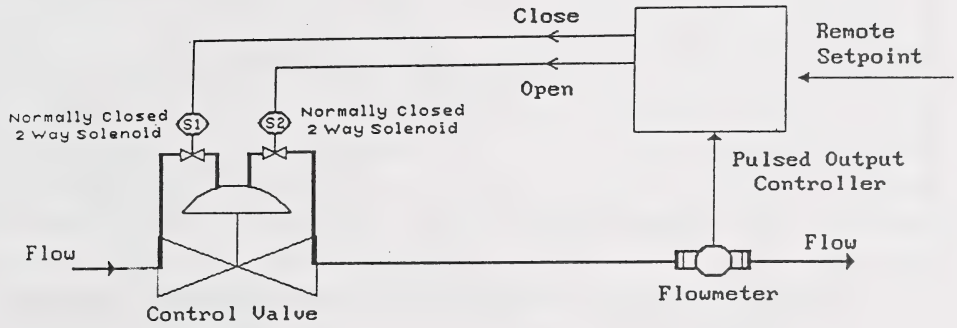


Figure 1 Reservoir Fill Valve Control

The City's primary reservoirs are situated to ensure normal service levels are provided to all customers for when the treatment plants are temporarily shutdown for maintenance or operational problems. The secondary reservoirs have been arranged to provide adequate backup support with two or more reservoirs for each supply zone. A reasonable redundancy is needed for flexibility in operation, security in supply and for routine maintenance activities to be scheduled to proceed with no inconvenience to the customers.

In the City's case, the operation of a water utility system with two treatment plants, ten reservoirs and two booster stations requires that special attention be given to properly manage the system in a cost effective manner. The management of power consumption and costs must be controlled by an operating strategy, yet at the same time water quality must not be compromised. The City achieves this by utilizing facilities with the least number of small pumps and by maintaining a minimum of 8 % volume use per day average for each month.

Demand Management Condition	Declining Storage Value (%)	Demand Management Response
A	65% and depleting	Reduce water supply pressures to 30 kPa above alarm limits and advise utility sub-sections and Managers
B	50% and depleting	Reduce water supply pressures to +/- 5 KPa of Al Ann limits and request all City departments to discontinue unnecessary water use.
C	35% and depleting	Reduce water supply pressures to 30 KPa below alarm limits and release a media request for all unnecessary outside water use to be discontinued.

Table 1.0
Demand Management Measures For Declining Storage Volumes

Maintenance

A Preventative Maintenance (PM) Program is essential for the planning, scheduling and budgeting for all aspects of operating a facility. Routine reservoir checks by operations staff provides a vital link for communication between the operation and maintenance sections. As part of the City's PM program operations staff conduct on a weekly basis inspections of all reservoirs and booster stations. A weekly routine inspection program provides a visual check of all equipment, data recording charts, Bump pump operation, pump run time, power consumption readings, valve exercising, diesel power generator test runs, leak inspection, chlorine residual/pH field tests and general security checks. In addition to checks performed by operations staff, Millwrights and Instrumentation/Electrical staff also conduct monthly routine PM checks.

Each reservoir of the City's distribution system is scheduled for routine inspection, cleaning and disinfection every 5 years. Minor structural repairs are also conducted if deemed necessary. Throughout each year short term draw down tests are conducted to determine pump performance and accuracy of metering. Long draw down tests are also sometimes conducted in case of discrepancies to allow for a more accurate and controlled test. During a draw down test, the water quality to the customer is monitored to ensure it is maintained as deposits of calcium carbonate can become disturbed and possibly distributed to the customer. Once the 1 m water

level has been reached in the reservoir, chlorine residual field tests are taken in 15 minute intervals to ensure the City operating guidelines are maintained at > 1 mg/L. Turbidity tests are also conducted to ensure a water supply of less than 1 NTU. Regular cleaning and quality control ensures a high quality of water in the reservoir. It also minimizes the volume of treated water that must be wasted during reservoir shutdowns thus minimizing lost revenues and shutdown time.

Once the reservoir is drained, all valves and pumps are tagged and locked out prior to entrance into the cell. Samples of calcium carbonate sludge from the floor are collected and returned to the Quality Control Laboratory for microbiological analysis. The wash lines and fill/suction piping are inspected for corrosion damage. The concrete structure is also inspected for cracks, leaks, spaulding, exposed rebar and condition of joint seals. Minor deficiencies may be repaired during the shutdown or logged and scheduled for a longer repair shutdown in the future. The ease of valve operation and ability to achieve a good shutdown are recorded on the procedures sheet for future reference. Following inspection the reservoir is washed and cleaned by a three person team using fire hoses connected onto the discharge header. If assessable, the suction header and the Bump pit are drained, inspected and cleaned.

The final phase of the reservoir inspection before returning it to service is disinfection. A spray method for the disinfection of the reservoir walls and floor has been used since 1988 with excellent results. This method has reduced substantially the down time and amount of water wasted. A solution of sodium hypochlorite is prepared in a 4000 litre plastic barrel to a concentration of 250 mg/L. A high pressure wash pump is mounted on top of the barrel with a sufficient length of 25 mm high pressure hose attached to reach the furthest part of the reservoir where the hose is then split into two sections with fine spray wands attached at the ends. The pump, complete with two pressure relief switches is operated at between 700 to 1400 KPa. The floor, walls and pillars are disinfected in a systematic pattern finishing at the pump suction and entrance way. All disinfectant spray equipment and lights are then removed and the reservoir is filled to a level to cover the entire floor area. The water in the reservoir is left for 24 hours after which laboratory samples are collected for bacteriological tests and standard water quality tests. Bacteriological tests include Standard Plate Counts and Total and Fecal Coliforms. Standard water tests include; volatile organic carbon concentration (VOC), trihalomethanes (THM), chlorine residual, pH, turbidity and colour. If the results from the samples collected are within the operating guidelines the reservoir is filled continually to a normal operating volume equal to 35 % its capacity by the following day. Only after 48 hours when the bacteriological results are finalized and satisfy the

operating guidelines is the reservoir completely filled and returned to service. The implementation of this new reservoir cleaning method has reduced the down time from four weeks to less than two weeks. Summarized in Table 2.0 is a typical time schedule required to complete a routine reservoir cleaning.

Day	Activity
Sat./Sun.	Normal operation, but draw down level to the low cut off by 0700 hrs Monday
Monday	Continue draw down with field tests for chlorine residual > 1 mg/L or turbidity < 1 NTU. Set up all wash equipment, lights and disinfectant equipment and conduct final inventory check. Begin to drain overnight.
Tuesday	Open reservoir access and move all required equipment in and collect laboratory samples, conduct structural inspection and begin wash.
Wednesday	Complete the washing, setup the disinfection equipment and conduct final inspection.
Thursday	Disinfect and fill to a level which covers the entire floor area.
Friday	Draw water samples for bacteriological testing and standard water quality tests. Leave only the fill valve in remote control.
Saturday	If 24 hour bacteriological results and the water quality parameters are within the guidelines proceed to slowly fill to a volume of 35%.
Sunday	If 48 hour bacteriological results meet the guidelines continue to fill to a volume equal to all reservoirs.
Monday	Return all valves and pumps to normal operation. The station is now online.

Table 2.0
Typical Schedule For a Routine Reservoir Cleaning

A microbiological study of two reservoirs was conducted in which samples of sludge, corrosion tubercles, concrete wall scrapings and debris were examined for Heterotrophic Plate Counts (HPC), fungi, and Total and Fecal Coliforms. The results of this preliminary study indicate that the most susceptible materials for microbial deterioration are metal components and grouting material of high organic content. Deterioration of these materials appears to support high numbers of microorganisms. For example, the wall and floor grouting was able to support very

high levels of microorganisms, including fungi. Another area favourable to microbial attack are areas of stagnation within the reservoir. Areas of severe stagnation such as corners and along the walls appear to be most susceptible to microbial attack. Summarized in Table 3.0 is the microbiological results from sampling of the Orsmby reservoir.

Design

The function and philosophy of a reservoir storage system must be well defined at the time of design. In Edmonton, a high 5 day philosophy has been adopted for determining the required storage volume. Based on this philosophy the reservoir storage is designed to be depleted in 5 consecutive days of high demand while there is occurring maximum resupply to the reservoir. At the end of this high demand period it is assumed that the reservoir storage will be replenished. Edmonton's topography is relatively flat and allows 75 % of the existing service area to be supplied directly from the water treatment plants during low to average daily demands. However, large storage volumes are required for peak summer demand conditions and during long scheduled plant shutdowns. The transmission mains radiating from the source are dual purpose in that they provide a direct connection to the distribution system and that they act as a fill and discharge lines to the reservoirs at the outer boundary of the service area. Beyond this outer boundary there are two secondary pressure zones which service areas of higher elevation that cannot be adequately supplied from the primary zone.

Over the past ten years the Engineering, Operations and Maintenance sections have worked more closely to resolve the inadequacies associated with the reservoir designs. Overall the system planning aspects were addressed, however, seasonal operation and maintenance requirements were given little consideration. Inconsistencies in the designs of both reservoirs and booster stations have made it difficult in understanding how a facility was to be operated. The vast difference in size, shape, pump capacities and piping configurations between the reservoirs suggests that their function and performance requirements were not well defined at the time of their design.

Most City reservoirs have been constructed to consist of more than one cell, usually all of equal size. The advantage of having more than one cell at each reservoir site, is individual cells can be taken out of service with no interruption to the normal level of supply or fire demand capabilities. In addition, having small individual cells reduces the problem of stagnation typical in large cells. However, to avoid stagnation problems the City has modified many of its reservoirs to have the inlet

and outlet piping designed to maximize circulation to ensure uniform water quality. This has been achieved by designing an inlet header which spans the inlet wall and distributes equally the incoming flow. In addition, inlet flow control is modulated by either two control valves or by a by-pass line which allows maintenance on the equipment and provides an alternate control for filling. The piping in all secondary supply reservoirs have been configured to allow them to be operated as booster stations during unplanned shutdowns. An example for this requirement is when a single cell reservoir is out service and the alternate supply has limited capabilities due to hydraulic losses within the system.

Sample Location	Fecal Coli (cfu/100 ml)*	Total Coli (cfu/100ml)*	HPC (20^0C,7d cfu/ml)*	HPC (35^0C, 48 hr, cfu/ml)*	Fungi (20^0C,48 hr, cfu/ml)*
Wall Scraping	<1	<1	1×10^7	1×10^7	1×10^4
Wall Grout	<1	<1	5×10^7	$>3 \times 10^6$	<1
Wall Corrosion Tubercle	<1	<12	6×10^7	1×10^5	<1
Floor Tubercle	200	500	5×10^5	3×10^3	<1
Tubercle From Overflow Pipe	<1	<1	4×10^5	2×10^4	<1
Tubercle From Inlet Pipe	40	70	3 x 104	200	<1
Floor Grout					

* per gram or 100 g for solid samples

Table 3.0
Microbiological Results From Sampling of the Orsmby Reservoir.

Other features that are of particular importance to Operations and Maintenance staff is the drainage of reservoirs. It has been observed reservoirs with large sized drains which go into an 84 inch diameter or larger storm sewers are a great advantage as they permit over night draining. If possible reservoirs should not be designed to have them drain into Bump pits in which the water is pumped to the storm sewer using relatively small pumps. Some of the City's reservoirs have this type of arrangement and consequently more time must be allowed for when draining. In addition, the man hours associated to this time delay can be costly. New City reservoirs are now designed to have them drain, whether directly or by Bump pit, the bottom 25 ~O

volume in less than 24 hours. Access to a reservoir is also of importance. Typically, access to a reservoir is limited to personnel and small light weight tools and equipment. The City has found access to its reservoir inadequate for routine cleaning, major repairs, re-chalking or during pipe replacement. The capital investment to designing and building an adequate reservoir access is easily offset by the costs that would be incurred by the increase in down time due to difficulty in moving equipment in and out of the reservoir during cleaning or construction repairs.

Conclusion

A variety of personnel with varied education, experience and dedication to the design, operation and maintenance of a water utility are needed if a system is to be properly developed, improved or optimized. Important aspects which must be considered by this group in the design of water distribution reservoirs are as follows.

i. The philosophy used to determine the storage volume required must be well defined with the rationale to support it.

ii. Engineering and Operations sections must agree, prior to the design of the reservoir, on its function and how it may change with time or under different operational scenarios.

iii. The interests of Engineering, Operations and Maintenance staff must be considered in the detailed design of a reservoir to ensure the facility will be safe, easily maintainable and operational efficient so as to provide the best quality of water to customers.

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